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**(54) METHOD AND APPARATUS FOR STEAM PASTEURIZATION OF MEAT**

**METHODE UND VERFAHREN ZUM DAMPF PASTEURISIEREN VON FLEISCH**

**PROCEDE ET APPAREIL DE PASTEURISATION DE VIANDE A LA VAPEUR**

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## Description

### Field of the Invention

[0001] This invention relates generally to apparatuses and processes for cleaning meat, and more particularly, to a processor and method for destroying coliform bacteria and other surface pathogens on meat.

### Background of the Invention

[0002] Concerns over pathogens on meat have been elevated in recent years due to E-coli related illnesses and deaths. In response, certain regulations have been imposed on food preparers and recommendations have been made to increase the likelihood that pathogens are killed. For example, restaurants must cook hamburger at 70°C (160°F) throughout for at least five seconds.

[0003] Such end user regulations have been made in an attempt to correct a problem that begins during meat processing. E-coli, other coliform bacteria, and many other pathogens reside on the surface of meat beginning with the meat carcass processing. The pathogens originate from fecal matter and other contaminants on the surface of the meat. Without adequately destroying these pathogens, the meat is processed, packed, and shipped to the distributor, retailer, or consumer. It is then left to the consumer or preparer of the meat to address a problem that by then can be even worse. The bacteria may have further grown or may reside throughout the meat. This is the case, for example, with ground meat since during meat processing the surface pathogens are distributed throughout the meat.

[0004] The only precaution currently taken by the meat processors is to spray the carcasses with water at 49-60°C (120-140°F). This measure is not necessarily effective or efficient at destroying the surface pathogens. Not all pathogens are killed at these temperatures and large volumes of water are required, along with a large amount of energy to heat the water, since the water cannot easily be recirculated if contaminants are to be avoided.

[0005] Several prior patents have addressed the issue of treating meat for bacteria contamination, but it is not known whether any of these methods have been successful or are actually in use. French Patent No. 2 497 072 discloses a method of spraying hot water or steam (at a temperature of from 90-100°C) to a meat unit surface for approximately one minute. A cooling fluid is then washed over the meat surface for approximately 15 seconds. An optional step of drying the meat after steam treatment and before cooling is disclosed, although the purpose of such step is not discussed.

[0006] U.S. Patent No. 4,255,459 discloses a method and apparatus for steam injection for blanching of small food particles, where the heat applied is sufficient to penetrate through the entire particle.

[0007] GB Patent No. 23,266 discusses a process for pasteurizing meat wherein superheated steam is sprayed on the exterior of a meat carcass.

[0008] The process and apparatus of the present invention were developed to effectively and efficiently stop pathogen-infested meat and poultry products from reaching the end user.

### Summary of the Invention

[0009] The difficulties and drawbacks of the prior art methods and apparatuses for destroying coliform and other pathogenic bacteria on the surface of meat such as beef, poultry, pork and other meat products are addressed by the apparatuses and methods of the present invention. The apparatuses and methods of the present invention destroy pathogenic bacteria and other harmful contaminants on all the surface areas of the meat without introducing chemicals or other harmful and expensive products into the process. The methods and apparatuses are also carried out effectively and inexpensively.

[0010] An apparatus for destroying pathogens on meat is disclosed. The apparatus includes a dewatering chamber, a steam heating chamber, a chilled water chamber, and a meat conveyor. The dewatering chamber includes an air blower with nozzles for blowing air at the surface of the meat to remove surface water from the meat. The steam chamber is disposed adjacent the dewatering chamber. The steam chamber includes a steam chamber enclosure that is sealed for maintaining a positive pressure in the steam chamber relative to the dewatering chamber. The steam chamber also includes a steam supply line for filling and maintaining the steam chamber with steam. The chilled water chamber is disposed adjacent the steam chamber opposite from the dewatering chamber. The chilled water chamber has nozzles for spraying chilled water onto the surface of the meat for rapidly cooling the meat, after it is passed through the steam chamber. The meat conveyor extends through the dewatering chamber, the steam chamber, and the chilled water chamber. The meat conveyor supports the meat and transfers it from chamber to chamber. A method for destroying pathogens on meat is also disclosed that includes the steps of removing surface water from the meat, passing the meat through a steam heating chamber having a positive pressure relative to the outside of the steam chamber, to quickly heat the exterior of the meat then rapidly chill the surface of the meat.

[0011] The steam chamber further includes a floor that is sloped to collect the condensate that drips from the meat. At the lowest point in the floor a pressure retaining drain allows the water to be channeled away from the steam chamber without release of pressure therefrom. The steam chamber enclosure also includes pressure retaining entrance and exit doors to maintain the positive pressure in the steam chamber as meat

enters and exits the steam chamber. The steam chamber also includes a steam distribution system extending along the length of the steam chamber enclosure and including outlets to dispense steam into the steam chamber.

[0012] The air nozzles in the dewatering chamber are preferably arranged in banks on either side of the conveyor that transfers the meat, such that the meat is advanced between the two banks of air blower nozzles. An enclosure around these air nozzle banks is also preferably provided.

[0013] The chilled water chamber also includes, preferably, water spray banks on either side of the conveyor for spraying chilled water over the entire surface of the meat. An enclosure also surrounds the chilled water sprayers to form a chilled water chamber.

[0014] An alternate preferred method for destroying pathogens on meat that is attached to a conveyor is also disclosed. The method includes moving at least one first unit of the meat (e.g. a beef carcass) into a movable steam chamber, moving the steam chamber with the first unit enclosed therein along the conveyor, subjecting the first unit to steam within the steam chamber, removing the steam chamber from the first unit, and rapidly chilling the surface of the first unit of the meat. Subjecting the first unit to steam heats the surface of the first unit of meat to destroy the pathogens.

[0015] In a preferred embodiment, the steam chamber moves at substantially the same rate as the conveyor during the step of moving the steam chamber. In this manner, the steam chamber does not have to be stopped while steam surrounds the first unit of meat. The step of removing the steam chamber from the first unit of meat is preferably carried out by moving the steam chamber in a direction opposite the direction of travel of the conveyor along the path of the conveyor. Preferably, the steam chamber includes an entrance door at the upstream end of the steam chamber and an exit door at the downstream end. The method further includes closing the entrance door after the first unit moves into the steam chamber and opening the entrance and exit doors before removing the steam chamber from the first unit.

[0016] A second unit of meat may next be enclosed within the steam chamber upon removing the steam chamber from the first unit. The steam chamber is rapidly evacuated of steam before the step of removing the steam chamber from the first unit.

[0017] The step of rapid chilling is carried out by directing a coolant fluid at the surface of the first unit of meat. The temperature of the coolant fluid is lower than that of the surface of the meat. The coolant fluid preferably includes water and may contain an antimicrobial agent in the water. Alternatively, the coolant fluid may include ambient air or another gas that may be cooled relative to the ambient air.

[0018] The method of the present invention preferably includes a step of dewatering the first unit of meat

before moving the meat into the steam chamber. Furthermore, the steam surrounding the meat within the steam chamber may alternatively be superheated or subcooled.

5 [0019] The process may be monitored by recording heat-treating conditions of the first unit of meat by ascertaining the initial surface temperature, the surface temperature as the meat is subject to the steam, and the surface temperature after being chilled. The length of heat treatment may also be ascertained and recorded. Rather than measuring the surface temperature of each unit of meat within the steam chamber, this information may be determined by measuring the temperature within the steam chamber as the meat is being transferred into the steam chamber, during the steam treatment process and also during the cooling process. Standard temperature gauges may be utilized for monitoring the temperature within the steam chamber.

10 [0020] Another preferred apparatus for pasteurizing meat held by a conveyor, as the meat is carried along by the conveyor, is also provided. This preferred apparatus includes a stationary frame, a steam chamber and a cooling system. The stationary frame extends along a portion of the conveyor. The steam chamber is movably coupled to the stationary frame and is sized to enclose at least one piece of meat being held by the conveyor. The steam chamber includes a drive system to move the chamber along a portion of the conveyor to heat the surface of the meat as the meat moves with the conveyor. The steam chamber includes an upstream end and a downstream end. The steam chamber drive system is operable to retract the steam chamber along the stationary frame in a direction opposite to the direction of movement of the conveyor. The cooling system is associated with the stationary frame and is for rapidly cooling the surface of the meat that has been heated by the steam.

[0021] The apparatus may also include a stationary enclosure associated with the stationary frame. The stationary enclosure surrounds the steam chamber and may also surround the cooling system. A vacuum system is secured to the stationary enclosure and is operatively engaged with the steam chamber to evacuate steam therefrom.

45 [0022] The steam chamber includes an entrance door attached thereto at the upstream end of the steam chamber. An exit door is also provided attached to the steam chamber at the downstream end. The exit door preferably includes curved panels with concave sides facing the interior of the steam chamber. The panels include actuators for opening and closing the steam chamber.

50 [0023] The cooling system preferably includes fluid jets attached to the stationary frame. The fluid jets may be water jets, air jets or other types of jets.

55 [0024] An alternate preferred embodiment of the invention includes a system for removing surface liquid, a steam supply and a system for cooling the surface of

meat, all carried within a chamber. The chamber receives, and at least partially encloses, the meat. The system for removing surface liquid from the meat may be both secured to the inside of the side walls of the chamber, as well as the system for cooling the surface of the meat. The steam supply is coupled to the chamber to apply steam to the surface of the meat. The meat preferably hangs from and moves along a conveyor. The apparatus also includes a stationary frame located below the conveyor, with the chamber being powered to move relative to the frame. Thus, the chamber moves along the path of the conveyor with the meat such that the meat can be processed as the meat moves. The system for removing surface liquid preferably includes fluid lines attached to and extending within the chamber. The fluid is blown at the surface of the meat within the chamber to remove excess surface liquid from the meat prior to steam treatment. The cooling system preferably includes a coolant fluid supply and coolant lines attached to and extending within the chamber. The coolant may be applied to the surface of the meat within the chamber after steam treatment of the meat.

#### Brief Description of the Drawings

[0025] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a schematic plan view of the process and apparatus of the present invention illustrating the movement of a side of beef along an overhead conveyor through the various chambers of the present invention;

FIGURE 2 is a semi-schematic elevational view of the dewatering chamber of the present invention;

FIGURE 3 is a semi-schematic elevational view of the steam chamber;

FIGURE 4 is a semi-schematic elevational view of the chilled water chamber of the present invention;

FIGURE 5 is an isometric view of another preferred embodiment of the present invention showing meat being moved through a processor;

FIGURE 6 is a top view of the processor of FIGURE 5 showing a steam chamber in a retracted position;

FIGURE 7 is a top view of the processor of FIGURE 5 showing the steam chamber being retracted as the meat continues to move in a downstream direction;

FIGURE 8 is a cross-sectional elevational view showing the steam chamber in the position shown in FIGURE 6;

FIGURE 9A is a cross-sectional end view showing the circulation of steam through the steam chamber;

FIGURE 9B is a cross-sectional end view showing the coolant water being sprayed on a carcass after the steam chamber has been retracted;

FIGURE 10 is a sectional view showing the functioning of the protection plenum ventilation system; FIGURE 11A is an enlarged, fragmentary top view showing the entrance door;

FIGURE 11B is an enlarged, fragmentary top view showing the exit door; and

FIGURE 12 is an isometric view of an alternate preferred processor including dewatering, steaming, and cooling structures with a moving chamber; and, FIGURE 13 is a schematic view of a system for generating and supplying steam to the steam chambers of the present invention.

#### Detailed Description of the Preferred Embodiments

[0026] A schematic diagram of one preferred embodiment of the present invention is shown in FIGURE 1. A processor 10 is provided to rid the surface of unskinned or skinned meat M of any pathogens, such as *E-coli* 0157:H7 and other coliform-type bacteria, listeria, and salmonella. Processor 10 includes three chambers: a dewatering chamber 12, a steam heating chamber 14, and a chilled water cooling chamber 16. Meat M passes through each of these chambers in series. After passing through chilled water chamber 16 meat M has been cleansed from surface bacteria and is ready to be further processed by cutting, packaging, freezing, or otherwise. Note that while the preferred embodiment refers to beef, other meat can be processed with the apparatus and method of the present invention, such as pork or poultry. Also, while in the preferred embodiment the meat passes through different chambers to be processed, the meat could remain stationary while the process steps are carried out with corresponding equipment.

[0027] The first section of processor 10 entered by meat M is dewatering chamber 12. Dewatering chamber 12 includes a dewatering chamber enclosure 18 to seal off dewatering chamber 12 from external moisture or pollution. A processor entrance door 20 is provided at one side of dewatering chamber enclosure 18 to allow meat M to pass into dewatering chamber 12. Processor entrance door 20, as well as the other doors referenced below, is constructed in a pinwheel fashion with a plurality of door arms 22 extending outwardly from a central vertical axis about which the arms 22 rotate. A shield 24 is formed in circular arc sections to engage the outer ends of door arms 22. Shield 24 includes arcuate portions on both sides of door arms 22 such that a positive closure of dewatering chamber 12 is always achieved as door arms 22 rotate. At least two of door arms 22 will always be in contact with shields 24 to enclose the entrance to the dewatering chamber 12.

[0028] Alternatively, dewatering chamber 12 may be omitted from processor 10. The meat M would then sim-

ply enter steam chamber 14 directly.

[0029] Meat M rides through processor entrance door 20 hanging from a conveyor 25. Conveyor 25 is preferably constructed in a known fashion as a standard meat conveyor with an overhead chain to move the product along a processing stream. However, other conveyor systems may also be used.

[0030] After meat M passes through processor entrance door 20 it travels along conveyor 25 between left and right air banks 26 and 28. Air banks 26 and 28 remove surface moisture from meat M prior to meat M entering into steam chamber 14. Further details of air banks 26 and 28 are discussed below in connection with FIGURE 2.

[0031] Conveyor 25 then carries meat M to the exit side of dewatering chamber 12 and into the steam heating chamber entrance door 30. Steam chamber entrance door 30 closes the air path between dewatering chamber 12 and steam chamber 14 such that a positive seal is created between the two chambers. Steam chamber entrance door 30 is preferably similar in construction to processor entrance door 20. However, besides prohibiting contamination from entering steam chamber 14, steam chamber entrance door 30 also provides an air seal so that a positive pressure may be created in steam chamber 14 relative to dewatering chamber 12.

[0032] Steam chamber 14 includes a steam chamber enclosure 32 which functions to hold steam and a positive pressure therewithin. Conveyor 25 runs through steam chamber 14 from steam chamber entrance door 30 to a steam chamber exit door 38. Within steam chamber 14 a steam delivery pipe 34 delivers steam to a steam distribution pipe 36 which extends along the steam chamber 14. Further details of steam chamber 14 will be discussed below in connection with FIGURE 3.

[0033] Meat M then passes through steam chamber exit door 38 into cooling chamber 16. Steam chamber exit door 38 is similar in detail to steam chamber entrance door 30. Cooling chamber 16 includes an enclosure 40 that keeps the spray of chilled water within chamber 16 and keeps contaminants away from meat M. Cooling chamber 16 includes left and right chilled water spray banks 42 and 44, respectively. A processor exit door 46 is provided at the output side of chilled water chamber 16. Preferably, processor exit door 46 is similar in construction to processor entrance door 20. Conveyor 25 then carries meat M from processor 10.

[0034] As seen in FIGURE 2, conveyor 25 also includes a hook 48. Hook 48 is used to secure meat M such that meat M hangs therefrom as it travels through chambers 12, 14, and 16.

[0035] The details of dewatering chamber 12 will be discussed. Dewatering chamber 12 includes air manifold pipes 50 with nozzles 52. Manifold pipes 50 and nozzles 52 form left and right air banks 26 and 28. Nozzles 52 shoot air at high velocity at meat M, to substan-

tially remove surface water that may reside on the surface or in the crevices of meat M. The high pressure air is provided by left and right blowers 54 and 56. The air travels from the blowers through air pipe 50 and out nozzles 52 against meat M. Air banks are positioned on both sides of meat M so that standing areas or droplets of surface water are substantially removed from the entire surface of meat M before entering steam chamber 14. Removal of substantially all significant amounts of standing surface water is preferred so that, once within steam chamber 14, a significant amount of heat is not absorbed by surface water but instead is transferred directly to the surface of the meat to destroy pathogens. The surface of the meat may still be moist to the touch, but dewatering removes most standing water, whether it be areas of water on the meat surface, or just droplets of water.

[0036] Referring now to the semi-schematic elevational view of steam heating chamber 14 illustrated in FIGURE 3. An entrance valve 58 is provided at the top of steam chamber and closure 32 to deliver steam 60 through delivery pipe 34 and distribution pipe 36. Steam 60 is continually pumped into heating chamber 14 through pipe 36 such that a positive pressure is created within heating chamber 14. The preferred pressure differential is about 500 Pa (two inches of water). Other positive pressures could be used, preferably falling anywhere from about one-half to five inches of water relative to dewatering chamber 12 and the cooling chamber 16 as well as the outside environment. However, as little as 2.5 Pa (0.01 inches of water) pressure may be used. A positive pressure within steam chamber 14 helps to ensure that steam 60 very rapidly comes into contact with all surface areas of meat M and air is excluded from steam chamber 14.

[0037] As steam 60 contacts and surrounds meat M after it passes through steam chamber entrance door 30, steam 60 heats the surface of meat M. Steam 60 within heating chamber 14 is preferably at 100°C (212°F) at saturation. The steam 60 may be superheated to a temperature above 100°C (212°F). A pressure relief valve 62 is in communication with the heating chamber enclosure 32 to maintain the desired positive pressure within heating chamber 14.

[0038] As steam 60 envelops and contacts the surface of meat M, heat is drawn into the surface of meat M through steam contact. Steam condenses on the surface of meat M. The condensation of steam 60 onto the surface of meat M produces a transfer of heat energy, specifically the change-of-state energy from steam 60, to the surface of meat M. This transfer of energy heats the surface of meat M very quickly and effectively to kill any pathogens residing thereon.

[0039] As the condensation continues, water drips to the bottom of steam chamber 14. Steam chamber 14 is provided with a sloped floor 64 and a drain 66 at the bottom thereof to collect this water. Drain 66 is constructed such that pressure does not escape therefrom.

[0040] Meat M is preferably kept within steam chamber 14 for approximately 2½ to 30 seconds, 10 seconds being optimal. The surface of meat M is heated one to five microns deep at approximately 71°C-92°C (160°F-198°F) during this time. Meat M may also stay within steam chamber 14 a longer amount of time. However, between 2½ to 30 seconds is a preferred amount of time to maintain the surface of meat M between 70 and 92°C (160 and 198°F) to sufficiently reduce coliform bacteria, salmonella, and other pathogens. The preferred temperature range at the surface of meat M is between 70°C (160°F) to 92°C (198°F). The time within steam chamber 14 may be set by the speed of conveyor 25 combined with the length of steam chamber 14. The temperature of the meat surface may be extrapolated from temperature measurements taken at various locations, preferably about four, within steam chamber 14.

[0041] Cooling chamber 16 is provided to very rapidly dissipate the heat and thus stop the transfer of heat into meat M. Meat M enters into cooling chamber 16 after it passes through steam chamber exit door 38. See FIGURE 4. Once within cooling chamber 16, conveyor 25 transfers meat M between left and right spray banks 42 and 44. Chilled water at preferably about 4.4°C (40°F) is supplied by water supply pipe 68. The water passes through water valve 70 and into water delivery pipes 72. The water is under pressure such that it sprays through water nozzles 74 to contact and thus quickly chill the surface of meat M to remove the heat and provide a final rinse.

[0042] Meat M continues along the path of conveyor 25 through processor exit door 46. Meat M exits in a clean state with the surface of meat M effectively pasteurized from any fecal matter and the pathogens that accompany it or other contaminants that may be on the surface of meat M.

[0043] In summary, meat M passing through a dewatering chamber to remove excess moisture therefrom prevents surface moisture from absorbing the heat energy from the change of state of the steam in steam chamber 14 to condensation on the surface of meat M. This heat energy effectively destroys the pathogens. Afterwards, the chilled water in cooling chamber 16 rapidly cools the meat so that it is not significantly heated on the surface. This process is clean and effective. It does not employ objectionable chemicals, bacteria, radioactivity, or other expensive processes while ensuring that pathogens such as coliform bacteria, listeria, and salmonella are eliminated from the meat.

[0044] FIGURE 5 illustrates another preferred embodiment of the present invention. In this embodiment, a processor 110 destroys any disease-carrying material on the surface of the meat while the meat M is moving continuously along a conveyor path. It is not necessary to stop the conveyor path, but if the conveyor should stop while the meat is in the middle of processor 110, the meat is effectively cleansed and cooled.

[0045] Processor 110 includes a dewatering station

112, a steam chamber 114, and a cooling chamber 116. The steam chamber 114 and cooling chamber 116 are both contained within an outer enclosure 118. Outer enclosure 118 is generally parallelepiped in shape and includes an outer enclosure floor 119 that is peaked along the longitudinal center line of the floor. The floor 119 slopes towards the outsides of outer enclosure 118 for collection of condensate runoff from the meat. The cross-sectional size of outer enclosure 118 is somewhat larger than the typical size of a unit of meat M. The length of outer enclosure 118 is approximately 10 meters (33 feet) in the embodiment shown in FIGURE 5 that is adapted for use with sides of beef. Of course, the size, including the length, of the enclosure may be varied to accommodate different numbers of sides of beef to be treated at the same time and also for different types of meat, e.g., pork or poultry.

[0046] The processor 110 resides primarily below a standard conveyor 120 that is within the processing plant. A conveyor 120 includes a track 122 extending generally horizontally above the center of outer enclosure 118. Rollers 124 ride on top of track 122 and are pulled along by a drive chain 125. Hooks 126 extend below rollers 124 and into outer enclosure 118 as they move through processor 110. The meat M hangs from hooks 126 for processing.

[0047] The first stage of processor 110 includes dewatering station 112. Dewatering station 112 includes right air bank 128 and left air bank 130 positioned on the right and left sides of conveyor 120 respectively so as to direct a drying fluid, such as air, at the surfaces of meat M before meat M enters outer enclosure 118. As explained above with reference to the previously described embodiment, it is important to remove excess water from the surface of meat M before it enters steam chamber 114 so that effective heat transfer destroys any bacteria residing on the surface of meat M. Ideally, the drying air is directed at the meat shown in FIGURES 5-8 at a pressure of about  $1.034 \times 10^5$  Pa (15 psig) and at a high volume, i.e., of about 198 cubic meters (7000 cubic feet) per minute. Air banks 128 and 130 may alternatively be arranged in a different fashion. Also, other excess water removal methods may be employed.

[0048] Steam chamber 114 ideally extends approximately half of the length of outer enclosure 118. Also ideally steam chamber 114 rides within outer enclosure 118 at all times. Steam chamber 114 includes side walls 134 for enclosing meat M. The steam chamber is illustrated as sized to accommodate four units of meat M (e.g., carcasses) at the same time. A steam supply header 136 is attached to the top of outer enclosure 118 and directs steam into steam chamber 114 as described below with reference to FIGURE 9A. A pair of steam ventilation ducts 138 are also provided, attached to the top of outer enclosure 118 on either side of steam supply header 136. Steam ventilation ducts 138 are used to evacuate the steam S from steam chamber 114 as described below in further detail in connection with

FIGURES 9A and 9B.

[0049] A protection plenum 140 is provided all along the length of outer enclosure 118 immediately below track 122. Protection plenum 140 is a longitudinal enclosure provided with a negative pressure by pulling a vacuum with protection plenum duct 142 in order to keep any steam seepage from contact with the rest of conveyor 120. Preferably, protection plenum duct 142 is connected to at least two locations along trolley protection plenum 140 in order to create negative pressure within the protection plenum and to thus avoid damage to conveyor 120.

[0050] Steam chamber 114 also includes support wheels 144 disposed at the bottom of side walls 134. Support wheels 144 support steam chamber 114 above enclosure floor 119 so that steam chamber 114 may move longitudinally within outer enclosure 118.

[0051] A chamber drive 146 is attached ideally near the middle of outer enclosure 118 between outer enclosure 118 and steam chamber 114 in order to move steam chamber 114 within outer enclosure 118. Chamber drive 146 preferably includes a servo drive, a brake, a gear motor and a pinion 148. Pinion 148 is positioned at the bottom of chamber drive 146 and along the side of the bottom of steam chamber 114. Racks 150 are provided all along the bottom of side walls 134 of steam chamber 114. Thus, steam chamber 114 may be moved within outer enclosure 118 by rack 150 being driven by pinion 148 of chamber drive 146.

[0052] Horizontally disposed guide wheels 152 are also provided to engage the outer surface of rack 150 in order to prevent yaw of steam chamber 114 while it is being moved within outer enclosure 118. Guide wheels 152 are rotatably journeied on stationary brackets to the inside of outer enclosure 118. Chamber drive 146 is switched on when steam chamber 114 is filled with a desired number of units of meat M and moves steam chamber 114 at substantially the same rate of speed as conveyor 120, such that it moves along with meat M for a set period of time to apply steam S to meat M. Chamber drive 146 then quickly retracts steam chamber 114 to its start position as explained below.

[0053] Entrance doors 154 (not shown in FIGURE 5) and exit doors 156 are provided on the ends of steam chamber 114 in order to seal the chamber for application of steam S. Door actuators 158 are mounted to side walls 134 of the steam chamber 114 in order to open and close entrance and exit doors 154 and 156.

[0054] The downstream end of outer enclosure 118 contains chilled fluid banks 160. Chilled fluid banks 160 include pipes which channel a cooling fluid, preferably water, to coolant nozzles 162. Coolant nozzles 162 are directed to meat M to spray a coolant fluid on the surface of meat M in order to quickly reduce the surface temperature of meat M after steam chamber 114 is retracted from meat M. Once meat M passes between chilled fluid banks 160 harmful surface bacteria has been destroyed and meat M is ready to move on to addi-

tional processing steps and shipment to retailers and consumers.

[0055] FIGURES 6, 7 and 8 illustrate the movement of steam chamber 114 within outer enclosure 118 while meat M is processed with processor 110. Meat M, is supported by and moves along conveyor 120 during the entire process. Ideally the conveyor is moving at a substantially constant speed, but occasionally the conveyor speed may change, or the conveyor may even stop. Nonetheless, the present invention is capable of accommodating this change in conveyor speed.

[0056] As meat M enters into outer enclosure 118 it moves through entrance doors 154 into steam chamber 114. The distance between side walls 134 of steam chamber 114 is sufficient to enclose meat M therein. The length of steam chamber 114 is preferably long enough to enclose a desired number of units of meat M. Although four units are shown enclosed in FIGURES 6, 7 and 8, the length of the steam chamber 114 may be designed to accommodate a different number of units and also various types of meat.

[0057] Once four units of meat M enter into steam chamber 114, entrance door 154 and exit door 156 are closed by actuators 158. As soon as this occurs, steam chamber 114 begins to move along with meat M at the same rate as the movement of meat M while filling with steam (about 18 centimeters (7.1 inches) per second). Steam surrounds meat M preferably at a temperature of about 100°C (212°F) at sea level for a preferred length of time of 10 seconds. The temperature may be anywhere within the range of about 79°C (175°F)-260°C (500°F) and preferably surrounds the entire surface of meat M for a period of time between about 5 seconds and 30 seconds. The pressure within the chamber may be positive relative to ambient pressure to maintain steam purity. Temperature measurements are preferably taken at about four locations within steam chamber 114 and used to determine the temperature of the atmosphere within the steam chamber during the present process. Steam chamber 114 is moved within outer enclosure 118 by chamber drives 146 acting on rack 150. Guide wheels 152 stabilize the movement of steam chamber 114 as it moves with meat M.

[0058] As seen in FIGURE 7, once the desired time for application of steam to the surface of meat M has been met, entrance and exit doors 154 and 156 are opened and steam chamber 114 is quickly retracted back (preferably at about 12 feet per second) to the upstream end of outer enclosure 118 to enclose additional meat M to begin the process over again. Meanwhile, as shown in FIGURE 6, meat M that has been treated, continues to move through outer enclosure 118 within cooling chamber 116. Chilled fluid banks 160 spray coolant on the outer surfaces of meat M to rapidly decrease the surface temperature of meat M. This coolant prevents meat M from being cooked at its surface. The coolant W directed at meat M through nozzles 162 may be any coolant fluid such as air, water, or water, perhaps with



an antimicrobial agent mixed therein. Specific antimicrobial agents that may be used include lactic acid, trisodium phosphate, acetic acid, and chlorine dioxide.

[0059] Should conveyor 120 stop, steam chamber 114 will also be stopped by a switch that is triggered by movement or nonmovement of conveyor 120. Steam continues to be applied to meat M for the desired period of time after which doors 154 and 156 are opened and air is rushed through steam chamber 114 to evacuate steam S and to provide a cooling effect on meat M. Also, simultaneously the flow of chilled fluid may be started, which would assist in rapidly cooling the meat even though the fluid may not be actually spraying the surface of the meat. Thus, processor 110 can process meat with the continually moving line or with inadvertent stops in the line as meat M moves through processor 110. As such, the remaining processes within the plant that may cause conveyor 120 to stop can go on without worry of processor 110 and meat M being adversely affected.

[0060] FIGURES 9A and B illustrate the movement of steam S through steam chamber 114. FIGURE 9A illustrates the steam supply cycle as steam surrounds meat M and simultaneously pushes out any air surrounding meat M. Steam enters through steam supply header 136 through the top of outer enclosure 118. Chamber seals 164 provide a sealing engagement between the top of steam chamber 114 and outer enclosure 118. Steam supply header enters within the inside of chamber seals 164 such that the steam is channeled within side walls 134 of steam chamber 114. First and second deflection plates 166 and 168, respectively, are provided along the top of side walls 134 of steam chamber 114. First deflection plate 166 is nearest to steam supply header 136 and channels steam, as explained below in connection with FIGURE 10. Steam then surrounds and moves down along the top and sides of meat M while simultaneously pushing air out the bottom of steam chamber 114 through gas escape openings 170. Gas escape openings 170 are provided along the bottom of steam chamber 114 to allow air and steam to be pulled out of the bottom of steam chamber 114 up and through steam ventilation duct 138. As steam S is pumped into steam chamber 114 the heavier air moves toward the bottom and is pulled out of steam chamber 114 along the sides of steam chamber 114 within outer enclosure 118. Thus, steam uniformly covers the surface of meat M without any substantial air pockets. This ensures that adequate heat transfer takes place at the surface of meat M without any insulating effect of air. The volume of steam supplied to the steam chamber 114 to purge the chamber and treat the meat M is ideally about three to four times the volume of the steam chamber. However, depending on the temperature and pressure of the steam and other factors, more or less steam may be supplied to the steam chamber.

[0061] FIGURE 9B illustrates the cooling of meat M after steam is evacuated from steam chamber 114 and

steam chamber 114 is retracted from meat M which is now advanced to the downstream end of outer enclosure 118.

[0062] FIGURE 10 illustrates in further detail the flow of steam into steam chamber 114, as well as the functioning of protection plenum 140. As steam moves from steam header 136 it is channeled toward meat M with first deflection plate 166. First deflection plate 166 is approximately 40% open with holes formed therein, such that it allows some steam to enter directly to the top of meat M to fill steam chamber 114, while channeling additional steam to the opposite side of meat M to be directed down through second deflection plate 168 which is approximately 60% open. Thus, steam substantially evenly moves down all sides of meat M. Other ratios of openness of deflection plates 166 and 168 may be used depending on the pressure and volume of steam supplied, such that steam moves evenly over the surface of meat M to push air out the bottom of steam chamber 114 so that no pockets of air remain on the surface of meat M.

[0063] Also illustrated in further detail are chamber seals 164. Chamber seals 164 include an upper member 186 which is an inverted U-shape and a lower member 188 projecting upwardly from the top of outer wall 132 to meet within upper member 186. Upper members 186 effectively forms a channel beneath the top side of outer enclosure 118. Thus, little or no steam escapes through chamber seal 164.

[0064] Protection plenum 140 provides a channel for capturing escaped steam along the top of outer enclosure 118 beneath track 122. Steam is pulled out of protection plenum 140 with plenum ventilation duct 142 such that a negative pressure is maintained within protection plenum 140, relative to the interior of steam chamber 114 and to the ambient air. An upper plenum wiper seal 172 constructed of two strips of flexible rubber or similar material, that are angled upwardly and inwardly toward each, is provided at the top of protection plenum 140 to allow a nominally closed slot through which a conveyor brackets 184 may slide. When a conveyor bracket 184 is not between upper plenum seal 172, the two strips contact against each other to block steam from exiting the plenum. While brackets 184 pass along seal 172 some small openings may occur. However, since a negative pressure relative to the outside environment is maintained, air will be pulled into protection plenum 140 to be evacuated with steam S through plenum ventilation duct 142. Likewise, a lower plenum seal 174 is provided just above hook 126 to seal the lower side of protection plenum 140 and to evacuate any steam that may escape from outer enclosure 118 and from steam chamber 114. Lower plenum seal 174 also includes two rubber strips (or similar material) that are angled upwardly to meet at their uppermost ends and to provide a nominally closed slot through which bracket 184 may slide.

[0065] FIGURES 11A and B illustrate the details of



exit door 156 (FIGURE 11B) and entrance door 154 (FIGURE 11A). Exit door 156 includes door arms (halves) 176 that are pivotally attached to side walls 134 for sealing closure therewith. Actuator brackets 178 are secured to the outsides of side walls 134 and include a pivotal attachment to door actuators 158. The opposite end of door actuators 158 are secured to door brackets 180. Thus, retraction of actuator 158 causes door 156 to open while extension of actuators 158 causes door 156 to close. Door 156 includes door arms 176, each attached to a door bracket 180. The free ends of door arms 176 include hook-shaped door seals 182 that may be compressed one to another to provide an effective seal in the middle of door 156. The curved shape of door arms 176, with their connection to actuators 158, allows doors 156 to be opened and closed with minimal movement and space requirements outwardly from inner walls 134. Also, door 156 will open automatically when pushed by meat M.

[0066] Entrance doors 154 are somewhat similarly constructed. However, entrance doors 154 include actuators 158 attached to brackets fixed to outwardly extended portions of side walls 134. Side walls 134 flare outwardly near the upstream end of chamber 114 after which they extend in approximately parallel planes to the upstream end of chamber 114. This wider region of side walls 134 is necessary to accommodate the opening of door 154 inside of side walls 134. The pivot point of door arms 176 are at the upstream end of side walls 134. Supports 184 are provided to serve as a pivot for bracket 180 of door arms 176.

[0067] Another preferred alternate embodiment of the invention is provided and will be described in connection with FIGURE 12. In this embodiment removal of excess surface liquid from the meat M, the application of steam to the meat, and cooling, is all carried out within moveable chamber 214. Except for the elements described below, the aspects of this embodiment are similar to those described above with respect to FIGURES 5-11. For example, an outer enclosure 218, similar to enclosure 118 is provided along with a conveyor 220 and track 222. A protection plenum 240, similar to protection plenum 140 is also provided as well as a plenum duct 242, a steam supply header 236 and a steam ventilation duct 238. Likewise components 244, 246, 248, 250, 252 and 258 are similar to components 144, 146, 158, 150, 152, and 158 shown in FIGURES 5-11.

[0068] However, in the embodiment of the present invention show in FIGURE 12, in order to carry out all steps within chamber 214, air banks 228 and chilled water banks 260 are secured to the inside of side walls 234 of chamber 214. Air banks 228 are illustrated as extending in columns down both of the insides of side walls 234. Air banks 228 include openings for blowing a coolant fluid, such as air, at the surface of meat M to remove excess surface liquid. The excess liquid is removed before steam is applied to the surface of meat M within chamber 214 as meat M moves along conveyor

220. Air banks 228 are connected to air supply lines 290 which extend to within the top of enclosure 218. Air supply lines 290 are coupled to flexible air hoses 292 that extend within chamber 214 to be connected to air banks 228. Flexible air hoses 292 are used with extra length to enable movement of chamber 214, while maintaining a constant connection with fixed air supply lines 290. The fluid for removing excess liquid from meat M may be obtained from fluid supply tanks or simply from ambient air.

[0069] Similarly, chilled water banks 260 are connected to flexible coolant hoses 296 that run to coolant supply lines 294. Again, the flexibility of flexible coolant hoses 296 allow chamber 214 to move relative to coolant supply lines 294 while still maintaining a constant supply of coolant fluid for cooling meat M within chamber 214 as meat M moves along conveyor 220.

[0070] The process of this alternate embodiment begins with meat M entering into entrance door 254 (not shown). Meat M continues to move as four or other number units (or carcasses) of meat M are enclosed within chamber 214. During this time air banks 228 blow air at the surfaces of meat M to remove any significant amounts of standing liquid, such as water, from the surfaces. Once doors 254 and 256 are closed, and the meat surfaces are sufficiently free from standing water, steam supply header 236 fills chamber 214 with steam for a sufficient amount of time and at such a temperature and pressure to destroy any surface pathogens, as described above in connection with previous embodiments. During this time, chamber 214 continues to move along with meat M on conveyor 220. Steam is then evacuated from chamber 214 with steam ventilation ducts 238 and chilled water banks 260 spray the surface of meat M to cool meat M and prevent any cooking of the meat. Chamber 214 is then be retracted to enclose additional meat to repeat the same process.

[0071] FIGURE 13 illustrates applicants' unique system 300 for supplying steam to the steam chambers 14, 114 and 214 in sufficient quality and volume to very quickly purge and fill the steam chambers so that the meat M may be effectively and efficiently treated with the steam to destroy pathogens on the meat. To this end, the steam supply system 300 of the present invention includes a horizontally, elongate steam generation and storage vessel or tank 301 receiving steam from a boiler 302 or other steam source and supplying relatively large volumes of relatively low pressure steam to the steam chambers 14, 114 and 214 through outlet line 304.

[0072] To discuss the construction and operation of the steam supply system 300 in more detail, the vessel 301 is supported by spaced apart legs 306 in a standard manner. The vessel 301 is approximately half filled with water as indicated by 308. The water is at a temperature of approximately from 110° Celsius to about 130° Celsius. The level of the water 308 in tank 301 is maintained by a water level control system 310 capable of

sensing the water level in the tank and controlling valve 312 operably disposed in water supply line 314. Ideally, a manual shutoff valve 316 is also disposed in water supply line 314 upstream of valve 312. The makeup water is introduced into vessel 301 through an inlet 318 located at an elevation somewhat below the top of the water line. A pair of transverse baffles 320 are mounted within the interior of the vessel 301 to restrict the shifting of the water 308 longitudinally within the vessel 301 during, for instance, introduction of supply steam into the tank, as discussed more fully below. In a preferred embodiment of the present invention, the baffles are approximately 50% open.

[0073] The vessel 301 is fitted with an outlet valve 322 connected in fluid flow communication to the drain 324. The valve 322 may be used to flush the vessel 301. Also, an inspection manway 326 is built into the top of the tank 301 to allow personnel entrance into the interior of the tank.

[0074] The vessel further includes a relief valve system 328 to relieve the pressure of the steam within the vessel if necessary. During operation, the steam produced by the supply system of the present invention exits the vessel 301 at about  $1.44774 \times 10^5$  Pa (21 psia) to about  $2.75 \times 10^5$  Pa (40 psia). Of course, the pressure of the steam exiting the vessel may have to be altered depending on various factors, including the pressure drop experienced in the steam between vessel 301 and the steam chambers 14, 114 and 214, as well as the desired volumetric flow rate of the steam supplied at the steam chambers. In one embodiment, vessel 301 ideally is constructed from stainless steel at an ASME/CSA rating of 27.15 kg (60 pounds)/8.50 m<sup>3</sup> (300 cubic feet) steam service. The relief valve system 328 is used to make sure that the pressure of the steam within the vessel 301 does not exceed safe limits.

[0075] Saturated dry steam at from approximately  $4.137 \times 10^5$  Pa (60 psia) to  $6.895 \times 10^5$  Pa (100 psia) and at about from 144 to 164 degrees Celsius is supplied to vessel 301 through an inlet pipe 330 having an exterior nipple 332 connected to supply line 334 receiving this charging steam from a boiler 302 or other type of steam supply. Filters 336 are interposed in supply line 334 to filter out impurities therein. The pressure of the steam within the supply line 334 is controlled by a pressure control valve 338.

[0076] It is to be appreciated that the water in vessel 301 may be heated other than by use of charging steam. For instance, the water could be heated directly by an electrically or gas fueled heater or by steam heating coils.

[0077] Steam from vessel 301 is directed to the steam chambers 14, 114 and 214 through an outlet line 304 located at an upper central portion of the vessel. A monitoring system 340 monitors the temperature and pressure of the steam exiting the vessel 301 through line 304, which monitoring system is operably connected to valve 338 in the steam supply line 334. A steam baffle

342 is transversely located in the upper elevator of the vessel 301 to enhance the mixing of the steam within the vessel.

[0078] It will be appreciated that in the steam supply system of the present invention, the water 308 stored within the vessel 301 serves as a heat energy reservoir capable of being utilized to very rapidly generate relatively large volumes of steam. This is important in that to flush the steam treatment chambers 14, 114 and 214, steam at a volume of approximately three to four times the volume of the steam chambers is required to be introduced into the steam chambers very rapidly. Essentially, large charges of steam are instantaneously required by the steam treatment chambers 14, 114 and 214. The steam supply system of the present invention is capable of supplying such relatively large volumes of steam. To this end, ideally the volume of water in vessel 301 is about from 1/10 to 1/5 of the volume of the steam treatment chambers. Also, ideally the water in the vessel 301 occupies about from 1/3 to 2/3 of the volume of the vessel.

[0079] It will be appreciated that if steam were supplied to the steam treatment chambers 14, 114 and 214 from a storage vessel of pure steam, such storage vessel would have to be significantly larger in size than vessel 301 to be able to supply the steam at a rate fast enough to purge the steam treatment chambers and fill the chambers with treatment steam at a pace required by the present invention. If the steam were pressurized in an attempt to reduce the volume of such steam storage vessel, it is possible that the pressurized steam could cause hot spots and other damage to the meat being treated within the treatment chambers 14, 114 and 214. However, through the present invention, applicants are able to supply large volumes of relatively low pressure steam to the steam treatment chambers 14, 114 and 214.

## Claims

### 1. An apparatus for cleaning meat comprising:

- (a) means for removing surface water from the meat;
- (b) a steam heating chamber including an enclosure and a steam supply system to supply steam to within the enclosure to rapidly heat the exterior of the meat, the steam being applied to meat after the removing means have removed surface water from the meat; and
- (c) cooling means for chilling the surface meat heated by the steam.

### 2. The apparatus of Claim 1, wherein the steam heating chamber enclosure maintains a positive pressure within the steam heating chamber relative to outside the steam heating chamber.

3. The apparatus of Claim 1, wherein the steam heating chamber further comprises a floor having condensate collection means for collecting the condensate that is formed in the steam heating chamber. 5
4. The apparatus of Claim 1, wherein the means for removing the surface water from the meat includes air nozzles to blow air at the surface of the meat. 10
5. The apparatus of Claim 1, wherein the cooling means includes means for spraying chilled water at the surface of the meat.
6. The apparatus of Claim 1, further comprising a conveyor for supporting the meat during travel through the steam chamber, and past the cooling means. 15
7. The apparatus of Claim 1, wherein the steam supply system comprises: 20
  - (a) a storage vessel;
  - (b) a water supply system for supplying water to the storage vessel and maintaining the water at a desired elevation range within the storage vessel;
  - (c) means for heating the water in the storage to from 110°Celsius to 130°Celsius; and,
  - (d) a transfer system in steam flow communication with the storage vessel at a location above the level of the water in the storage vessel and in communication with the steam heating chamber. 30
8. The apparatus of Claim 1, wherein the chamber further comprises: 35
  - (a) a means for removing surface liquid from the meat within said chamber; and
  - (b) a means for cooling the surface of the meat within said chamber. 40
9. The apparatus of Claim 8, wherein the meat is attached to a conveyor to move along with the conveyor, the apparatus further comprising a stationary frame coupled to said chamber, said chamber being moveable relative to said frame along the path of the conveyor to move with the meat. 45
10. The apparatus of Claim 1, wherein: 50
  - (a) the steam chamber being moveable along the conveyor for movement within the conveyor as the meat moves with the conveyor, the steam chamber having an upstream end and a downstream end; and
  - (b) retraction means acting on the steam chamber for retracting the steam chamber along the conveyor, in a direction opposite to the direction of movement of the conveyor.
11. The apparatus of Claim 10, further comprising a stationary enclosure surrounding the steam chamber.
12. The apparatus of Claim 11, further comprising a vacuum source associated with the stationary enclosure to evacuate steam therefrom.
13. The apparatus of Claim 10, wherein the steam chamber is synchronized with the conveyor to move with the conveyor while heating the surface of the meat.
14. The apparatus of Claim 10, wherein the steam chamber includes an entrance closure attached thereto at the upstream end of the steam chamber and an exit closure attached thereto at the downstream end of the steam chamber.
15. The apparatus of Claim 14, wherein the exit and entrance closures comprise curved panels with concave sides facing in an upstream direction relative to the direction of movement of meat, the panels including actuators for opening and closing the steam chamber. 25
16. A method for destroying pathogens on meat comprising the steps of: 30
  - (a) removing surface water from the meat;
  - (b) heating the surface of the meat by exposing the meat to steam at a pressure above atmospheric pressure, the meat being exposed to the steam after the removing of surface water from the meat; and
  - (c) chilling the surface of the meat.
17. The method of Claim 16, wherein the step of removing surface water includes blowing a gas at the surface of the meat.
18. The method of Claim 16, wherein the step of chilling the surface of the meat includes spraying the meat with a chilled liquid immediately after exposure to the steam.
19. The method of Claim 16, wherein the meat surface is heated to a temperature of at least 60°C for at least 2½ seconds. 50
20. The method of Claim 16, further comprising supplying steam for heating the surface of meat by: 55
  - maintaining a storage vessel partially filled with water;

maintaining the water in the storage vessel at a temperature of 110°Celsius to 130°Celsius; and,

directing the steam generated in the storage vessel at an elevation above the water level in the vessel to the surface of the meat.

21. The method of Claim 16 being carried out while the meat is moving along a standard slaughter house conveyor, the method further comprising:

(a) removing standing water from the surface from the meat while the meat moves along the standard conveyor;

(b) enclosing the meat, with the moisture previously removed from its outer surface, in a steam chamber while the meat moves along the standard conveyor;

(c) filling the steam chamber with steam while the meat moves along the standard conveyor, the steam enclosing the meat and transferring heat to the surface thereof that has been dried by the previous removal of the standing water from the meat surface;

(d) removing the meat from the steam chamber while the meat moves along the standard conveyor; and

(e) directing a flow of cooling liquid to the surface of the meat while the meat moves along the standard conveyor to dissipate surface heat, such that the surface temperature of the meat is reduced.

22. The method of Claim 21, wherein the steam chamber is sealed and wherein a positive pressure relative to outside the chamber is attained within the steam chamber when the chamber is filled with steam.

23. The method of Claim 21, further comprising supplying steam to the steam chamber by:

maintaining a storage vessel partially filled with water;

maintaining the temperature of the water in the storage vessel at 110°Celsius to 130°Celsius by introducing steam into the storage vessel at an elevation below the top of the water level; and,

directing the steam generated in the storage vessel at an elevation above the water level in the vessel to the steam chamber.

24. The method of Claim 21, wherein the steam chamber moves with the traveling conveyor during the step of moving the steam chamber such that the conveyor does not have to be stopped while at least one first unit of meat is being subjected to the

steam.

25. The method of Claim 24, wherein the step of removing the steam chamber from the at least one first unit of meat is carried out by moving the steam chamber along the traveling conveyor in a direction opposite to the direction of travel of the conveyor.

26. The method of Claim 21, wherein the steam chamber is evacuated of steam during the step of removing the steam chamber from the at least one first unit of meat.

# Patentansprüche

1. Vorrichtung zum Säubern von Fleisch, umfassend:

(a) eine Einrichtung zum Entfernen von Oberflächenwasser von dem Fleisch;

(b) eine Dampfheizkammer mit einem Gehäuse und einem Dampfzufuhrsystem zum Zuführen von Dampf in das Innere des Gehäuses, damit das Äußere des Fleisches rasch erhitzt wird, wobei der Dampf auf das Fleisch aufgebracht wird, nachdem die Entfernungseinrichtung das Oberflächenwasser von dem Fleisch entfernt hat; und

(c) eine Kühleinrichtung zum Abkühlen der von dem Dampf erhitzten Fleischoberfläche.

2. Vorrichtung nach Anspruch 1, bei der das Dampfheizkammer-Gehäuse innerhalb der Dampfheizkammer gegenüber der Außenumgebung der Dampfheizkammer einen Überdruck aufrechterhält.

3. Vorrichtung nach Anspruch 1, bei dem die Dampfheizkammer außerdem einen Boden mit einer Kondensatsammeleinrichtung zum Sammeln des Kondensats aufweist, welches in der Dampfheizkammer gebildet wird.

4. Vorrichtung nach Anspruch 1, bei der die Einrichtung zum Entfernen des Oberflächenwassers von dem Fleisch Luftdüsen enthält, die Luft auf die Oberfläche des Fleisches blasen.

5. Vorrichtung nach Anspruch 1, bei dem die Kühleinrichtung eine Einrichtung zum Sprühen von gekühltem Wasser auf die Oberfläche des Fleisches enthält.

6. Vorrichtung nach Anspruch 1, weiterhin umfassend einen Förderer zum Halten des Fleisches während des Durchgangs durch die Dampfheizkammer und an der Kühleinrichtung vorbei.

7. Vorrichtung nach Anspruch 1, bei der das Dampfzufuhrsystem aufweist:

- (a) einen Speicherbehälter;  
 (b) ein Wasserzuführsystem zum Zuführen von Wasser zu dem Speicherbehälter und zum Halten des Wassers in einem Sollhöhenbereich innerhalb des Speicherbehälters;  
 (c) eine Einrichtung zum Erhitzen des Wassers in dem Speicher auf zwischen 110°C bis 130°C; und  
 (d) ein Transfersystem in Dampfströmungsverbindung mit dem Speicherbehälter an einer Stelle oberhalb des Wasserspiegels in dem Speicherbehälter und in Verbindung mit der Dampfheizkammer.
8. Vorrichtung nach Anspruch 1, bei dem die Kammer außerdem aufweist:  
 (a) eine Einrichtung zum Entfernen von Oberflächenflüssigkeit von dem Fleisch innerhalb der Kammer; und  
 (b) eine Einrichtung zum Kühlen der Oberfläche des Fleisches innerhalb der Kammer.
9. Vorrichtung nach Anspruch 8, bei der das Fleisch an einem Förderer befestigt wird, um es mit dem Förderer zu bewegen, wobei die Vorrichtung außerdem ein ortsfestes, mit der Kammer gekoppeltes Gestell aufweist, wobei die Kammer relativ zu dem Gestell entlang dem Weg des Förderers zum Bewegen des Fleisches beweglich ist.
10. Vorrichtung nach Anspruch 1, bei der  
 (a) die Dampfkammer entlang dem Förderer beweglich ist für eine Bewegung innerhalb des Förderers, während das Fleisch sich mit dem Förderer bewegt, wobei die Dampfkammer ein stromaufwärtiges und ein stromabwärtiges Ende besitzt; und  
 (b) eine auf die Dampfkammer einwirkende Rückzieheinrichtung vorhanden ist, um die Dampfkammer entlang dem Förderer in einer Richtung entgegen der Bewegungsrichtung des Förderers zurückzuziehen.
11. Vorrichtung nach Anspruch 10, weiterhin umfassend ein ortsfestes Gehäuse, welches die Dampfkammer umgibt.
12. Vorrichtung nach Anspruch 11, weiterhin umfassend eine Vakuumquelle in Verbindung mit dem ortsfesten Gehäuse, um aus diesem Dampf zu entfernen.
13. Vorrichtung nach Anspruch 10, bei der die Dampfkammer mit dem Förderer zum Bewegen des Förderers bei gleichzeitiger Erhitzung der Oberfläche des Fleisches synchronisiert ist.
14. Vorrichtung nach Anspruch 10, bei der die Dampfkammer einen an ihrem stromabwärtigen Ende befestigten Eintrittverschluss und einen an ihrem stromabwärtigen Ende befestigten Austrittverschluss enthält.
15. Vorrichtung nach Anspruch 14, bei dem der Austritts- und der Eintrittverschluss gekrümmte Wände mit konkaven Seiten aufweisen, die in stromaufwärtiger Richtung relativ zur Bewegungsrichtung des Fleisches weisen, wobei die Wände Aktuatoren zum Öffnen und zum Schließen der Dampfkammer aufweisen.
16. Verfahren zum Zerstören von Krankheitserregern auf Fleisch, umfassend folgende Schritte:  
 (a) Entfernen von Oberflächenwasser von dem Fleisch;  
 (b) Erhitzen der Oberfläche des Fleisches, indem das Fleisch Dampf bei einem Druck oberhalb des atmosphärischen Drucks ausgesetzt wird, wobei das Fleisch dem Dampf ausgesetzt wird, nachdem das Oberflächenwasser von dem Fleisch entfernt wurde; und  
 (c) Abkühlen der Fleischoberfläche.
17. Verfahren nach Anspruch 16, bei dem der Schritt des Entferns von Oberflächenwasser das Aufblasen eines Gases auf die Fleischoberfläche beinhaltet.
18. Verfahren nach Anspruch 16, bei dem der Schritt des Abkühlens der Oberfläche des Fleisches das Besprühen des Fleisches mit einer abgekühlten Flüssigkeit unmittelbar nach dem Aussetzen mit Dampf beinhaltet.
19. Verfahren nach Anspruch 16, bei dem die Fleischoberfläche auf eine Temperatur von mindestens 60°C während mindestens 2 1/2 Sekunden erhitzt wird.
20. Verfahren nach Anspruch 16, umfassend das Zuführen von Dampf zum Erhitzen der Oberfläche des Fleisches durch:  
 teilweises Gefüllthalten eines Speicherbehälters mit Wasser;  
 Halten des Wassers innerhalb des Speicherbehälters auf einer Temperatur von 110°C bis 130°C; und  
 Leiten des in dem Speicherbehälter in einer Höhe oberhalb des Wasserspiegels in dem Behälter erzeugten Dampfes zu der Fleischoberfläche.
21. Verfahren nach Anspruch 16, durchgeführt, wäh-

rend das Fleisch entlang einem Standard-Schlachthausförderer bewegt wird, wobei das Verfahren außerdem beinhaltet:

- (a) Entfernen stehenden Wassers von der Oberfläche von dem Fleisch, während das Fleisch sich entlang dem Standard-Förderer bewegt;
  - (b) Umschließen des Fleisches, von dessen Außenfläche zuvor die Feuchtigkeit entfernt wurde, in einer Dampfkammer, während sich das Fleisch entlang dem Standard-Förderer bewegt;
  - (c) Füllen der Dampfkammer mit Dampf, während sich das Fleisch entlang dem Standard-Förderer bewegt, wobei der Dampf das Fleisch einschließt und Wärme in dessen Oberfläche überträgt, die zuvor durch das vorherige Entfernen stehenden Wassers von der Fleischoberfläche getrocknet wurde;
  - (d) Entfernen des Fleisches aus der Dampfkammer, während sich das Fleisch entlang dem Standard-Förderer bewegt; und
  - (e) Leiten eines Kühlluftstroms auf die Oberfläche des Fleisches, während sich das Fleisch entlang dem Standard-Förderer bewegt, um Oberflächentemperatur des Fleisches niedriger wird.
22. Verfahren nach Anspruch 21, bei dem die Dampfkammer abgedichtet ist, wobei ein Überdruck relativ zu der Außenumgebung der Kammer innerhalb der Dampfkammer aufrechterhalten wird, wenn die Kammer mit Dampf gefüllt ist.
23. Verfahren nach Anspruch 21, weiterhin umfassend das Zuführen von Dampf zu der Dampfkammer durch:
- teilweises Gefüllthalten eines Speicherbehälters mit Wasser;
- Halten der Wassertemperatur in dem Speicherbehälter auf 110°C bis 130°C durch Einleiten von Dampf in den Speicherbehälter in einer Höhe unterhalb des Wasserspiegels; und
- Leiten des in dem Speicherbehälter in einer Höhe oberhalb des Wasserspiegels in dem Behälter erzeugten Dampfs in die Dampfkammer.
24. Verfahren nach Anspruch 21, bei dem die Dampfkammer sich mit dem laufenden Förderer während des Schritts des Bewegens der Dampfkammer derart bewegt, daß der Förderer nicht anhalten muß, während zumindest eine erste Fleischcharge dem Dampf ausgesetzt wird.

25. Verfahren nach Anspruch 24, bei dem der Schritt des Entfernens der Dampfkammer von der mindestens einen ersten Fleischcharge dadurch durchgeführt wird, daß die Dampfkammer entlang dem laufenden Förderer in einer Richtung entgegen der Laufrichtung des Förderers bewegt wird.

26. Verfahren nach Anspruch 21, bei dem die Dampfkammer während des Schritts des Entfernens der Dampfkammer von der mindestens einen ersten Fleischcharge von Dampf befreit wird.

#### Revendications

1. Appareil pour nettoyer un aliment tel que de la viande comprenant :
  - (a) des moyens d'enlèvement d'eau en surface de l'aiment ;
  - (b) une chambre de chauffage par vapeur comprenant une enceinte et un système d'alimentation en vapeur pour alimenter en vapeur l'intérieur de l'enceinte pour chauffer rapidement l'extérieur de l'aliment, la vapeur étant appliquée à l'aliment après que les moyens d'enlèvement ont enlevé l'eau en surface de l'aliment ; et
  - (c) des moyens de refroidissement pour rafraîchir l'aliment chauffé par la vapeur en surface.
2. Appareil selon la revendication 1, dans lequel l'enceinte de la chambre de chauffage par vapeur maintient une pression positive à l'intérieur de la chambre de chauffage par vapeur par rapport à l'extérieur de la chambre de chauffage par vapeur.
3. Appareil selon la revendication 1, dans lequel la chambre de chauffage par vapeur comprend en outre un sol ayant des moyens de collectage de condensat pour collecter le condensat qui est formé dans la chambre de chauffage par vapeur.
4. Appareil selon la revendication 1, dans lequel les moyens d'enlèvement d'eau en surface de l'aiment comprennent des buses d'air pour souffler de l'air à la surface de l'aliment.
5. Appareil selon la revendication 1, dans lequel les moyens de refroidissement comprennent des moyens pour vaporiser de l'eau rafraîchie à la surface de l'aiment.
6. Appareil selon la revendication 1, comprenant en outre un convoyeur de support pour l'aiment pendant son trajet à travers la chambre de vapeur, et au-delà des moyens de refroidissement.
7. Appareil selon la revendication 1, dans lequel le

système d'alimentation en vapeur comprend :

- (a) un récipient de stockage ;
- (b) un système d'alimentation en eau pour alimenter en eau le récipient de stockage et maintenir l'eau dans une gamme de hauteurs désirée à l'intérieur du récipient de stockage ;
- (c) des moyens pour chauffer l'eau dans le stockage de 110° Celsius à 130° Celsius ; et
- (d) un système de transfert en communication d'écoulement de vapeur avec le récipient de stockage à un emplacement supérieur au niveau de l'eau dans le récipient de stockage et en communication avec la chambre de chauffage par vapeur.

8. Appareil selon la revendication 1, dans lequel la chambre comprend en outre :

- (a) un moyen d'enlèvement de liquide en surface de l'aliment à l'intérieur de ladite chambre ; et
- (b) un moyen de refroidissement de la surface de l'aliment à l'intérieur de ladite chambre.

9. Appareil selon la revendication 8, dans lequel l'aliment est solidarisé à un convoyeur pour se déplacer avec le convoyeur, l'appareil comprenant en outre un châssis fixe couplé à ladite chambre, ladite chambre étant mobile par rapport audit châssis le long du trajet du convoyeur pour se déplacer avec l'aliment.

10. Appareil selon la revendication 1, dans lequel :

- (a) la chambre de vapeur est déplaçable le long du convoyeur pour un déplacement à l'intérieur du convoyeur lorsque l'aliment se déplace avec le convoyeur, la chambre de vapeur ayant une extrémité amont et une extrémité aval ; et
- (b) des moyens de rétraction agissent sur la chambre de vapeur pour rétracter la chambre de vapeur le long du convoyeur, dans une direction opposée à la direction du mouvement du convoyeur.

11. Appareil selon la revendication 10, comprenant en outre une enceinte fixe entourant la chambre de vapeur.

12. Appareil selon la revendication 11, comprenant en outre une source de vide associée à l'enceinte fixe pour évacuer la vapeur de celle-ci.

13. Appareil selon la revendication 10, dans lequel la chambre de vapeur est synchronisée avec le convoyeur pour se déplacer avec le convoyeur pendant

le chauffage de la surface de l'aliment.

14. Appareil selon la revendication 10, dans lequel la chambre de vapeur comprend une fermeture d'entrée solidarisée à celle-ci à l'extrémité amont de la chambre de vapeur et une fermeture de sortie solidarisée à celle-ci à l'extrémité aval de la chambre de vapeur.

15. Appareil selon la revendication 14, dans lequel les fermetures de sortie et d'entrée comprennent des panneaux incurvés avec des faces concaves tournées dans une direction amont par rapport à la direction du déplacement de l'aliment, les panneaux comprenant des actionneurs pour ouvrir et fermer la chambre de vapeur.

16. Procédé de destruction d'agents pathogènes sur un aliment tel que de la viande comprenant les phases de :

- (a) enlèvement d'eau en surface de l'aliment ;
- (b) chauffage de la surface de l'aliment en exposant l'aliment à de la vapeur à une pression supérieure à la pression atmosphérique, l'aliment étant exposé à la vapeur après l'enlèvement d'eau en surface de l'aliment ; et
- (c) rafraîchissement de la surface de l'aliment.

17. Procédé selon la revendication 16, dans lequel la phase d'enlèvement d'eau en surface comprend le soufflage d'un gaz à la surface de l'aliment.

18. Procédé selon la revendication 16, dans lequel la phase de rafraîchissement de la surface de l'aliment comprend la vaporisation de l'aliment avec un liquide rafraîchi immédiatement après exposition à la vapeur.

19. Procédé selon la revendication 16, dans lequel la surface de l'aliment est chauffée à une température d'au moins 60° C pendant au moins 2,5 s.

20. Procédé selon la revendication 16, comprenant en outre l'alimentation en vapeur pour le chauffage de la surface de l'aliment en :

maintenant un récipient de stockage partiellement rempli d'eau ;  
maintenant l'eau dans le récipient de stockage à une température de 110° Celsius à 130° Celsius ; et  
dirigeant le courant créé dans le récipient de stockage à une hauteur supérieure au niveau de l'eau dans le récipient vers la surface de l'aliment.

21. Procédé selon la revendication 16 mis en oeuvre



tandis que l'aiment est en déplacement le long d'un convoyeur d'abattoir standard, le procédé comprenant en outre :

- (a) l'enlèvement d'eau stagnante de la surface de l'aiment tandis que l'aliment se déplace le long du convoyeur standard ;
  - (b) l'enfermement de l'aliment avec l'humidité antérieurement enlevée de sa surface extérieure, dans une chambre de vapeur tandis que l'aliment se déplace le long du convoyeur standard ;
  - (c) l'emplissage de la chambre de vapeur avec de la vapeur tandis que l'aliment se déplace le long du convoyeur standard, la vapeur entourant l'aliment et transférant de la chaleur à la surface de celui-ci qui a été séchée par l'enlèvement antérieur de l'eau stagnante de la surface de l'aiment ;
  - (d) l'enlèvement de l'aiment de la chambre de vapeur tandis que l'aiment se déplace le long du convoyeur standard ; et
  - (e) le guidage d'un écoulement de liquide réfrigérant vers la surface de l'aliment tandis que l'aiment se déplace le long du convoyeur standard pour dissiper la chaleur de surface, de telle sorte que la température de surface de l'aliment soit diminuée.
22. Procédé selon la revendication 21, dans lequel la chambre de vapeur est étanche et dans lequel une pression positive par rapport à l'extérieur de la chambre est atteinte à l'intérieur de la chambre de vapeur quand la chambre est remplie de vapeur.
23. Procédé selon la revendication 21, comprenant en outre l'alimentation en vapeur de la chambre de vapeur en :
- maintenant un récipient de stockage partiellement rempli d'eau ;
  - maintenant la température de l'eau dans le récipient de stockage de 110° Celsius à 130° Celsius en introduisant de la vapeur dans le récipient de stockage à un niveau inférieur au haut du niveau de l'eau ; et,
  - dirigeant la vapeur créée dans le récipient de stockage à un niveau supérieur au niveau de l'eau dans le récipient vers la chambre de vapeur.
24. Procédé selon la revendication 21, dans lequel la chambre de vapeur se déplace avec le convoyeur de déplacement pendant la phase de déplacement de la chambre de vapeur de telle sorte que le convoyeur ne doive pas être arrêté tandis qu'au moins une première portion d'aliment est soumise à la vapeur.

25. Procédé selon la revendication 24, dans lequel la phase d'enlèvement de la chambre de vapeur de la au moins une première portion d'aliment est mis en oeuvre en déplaçant la chambre de vapeur le long du convoyeur de déplacement dans une direction opposée à la direction de déplacement du convoyeur.
26. Procédé selon la revendication 21, dans lequel la chambre de vapeur est vidée de sa vapeur pendant la phase d'enlèvement de la chambre de vapeur de la au moins une première portion d'aliment.

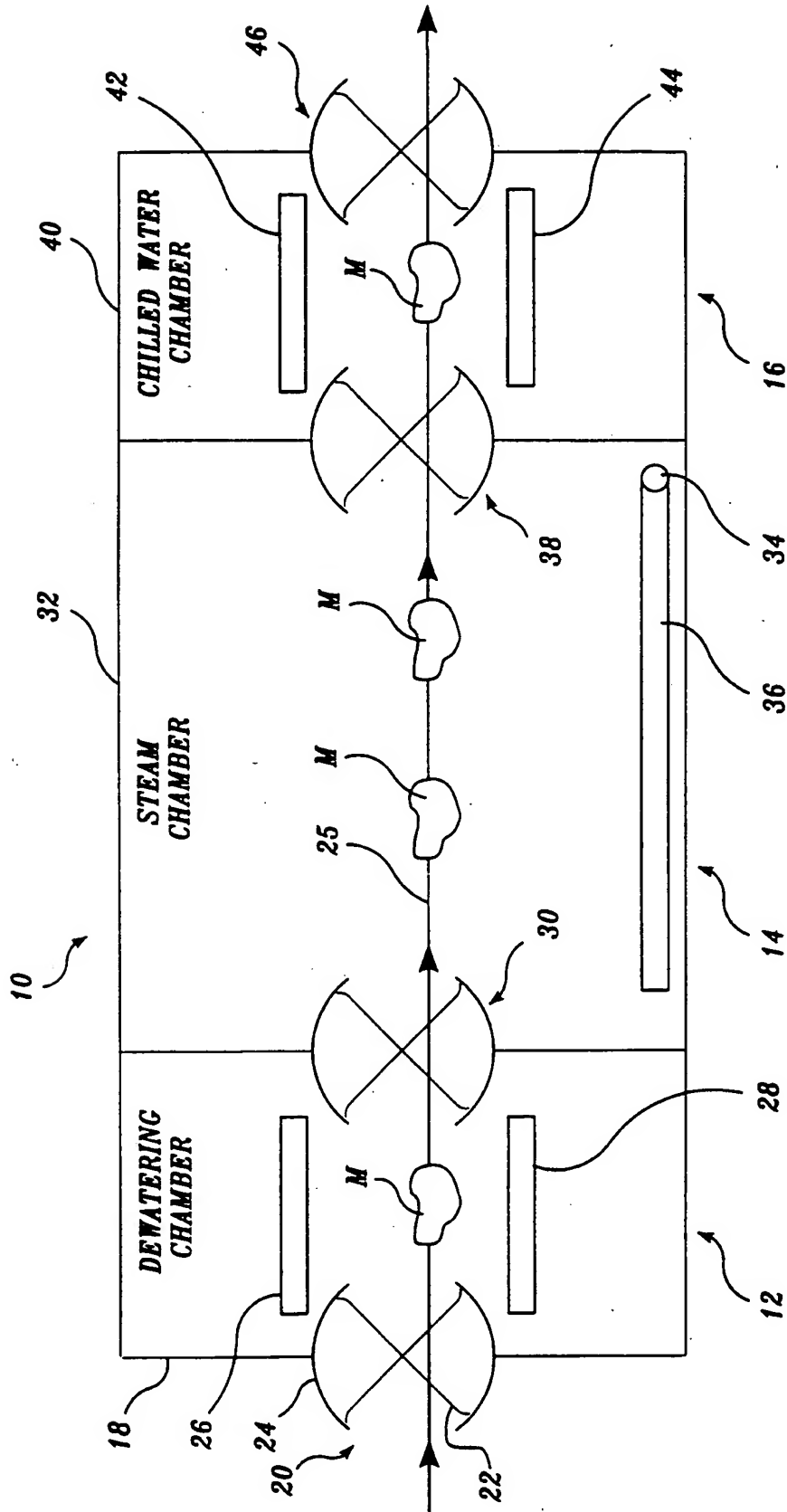


Fig. 1.

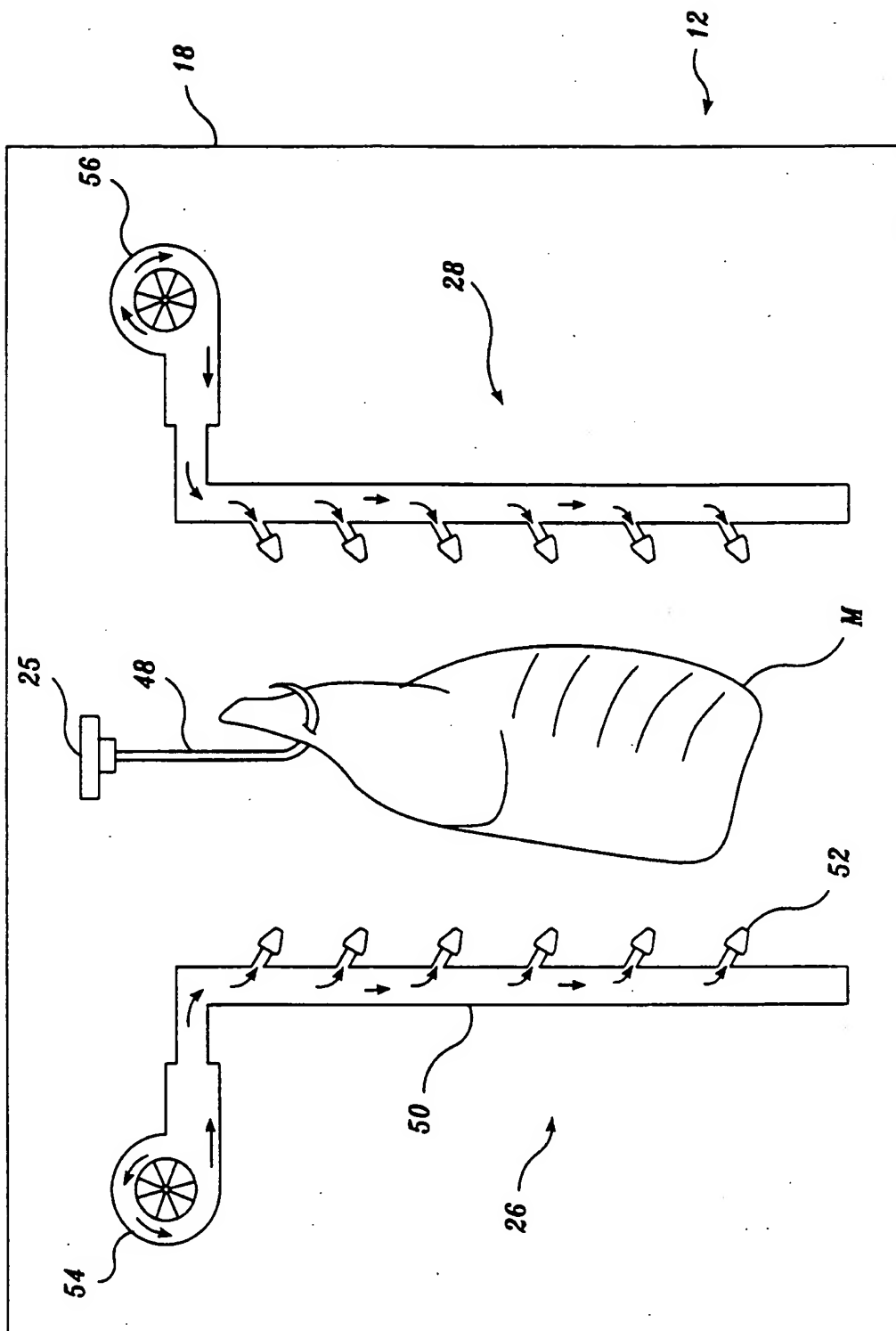


Fig. 2.

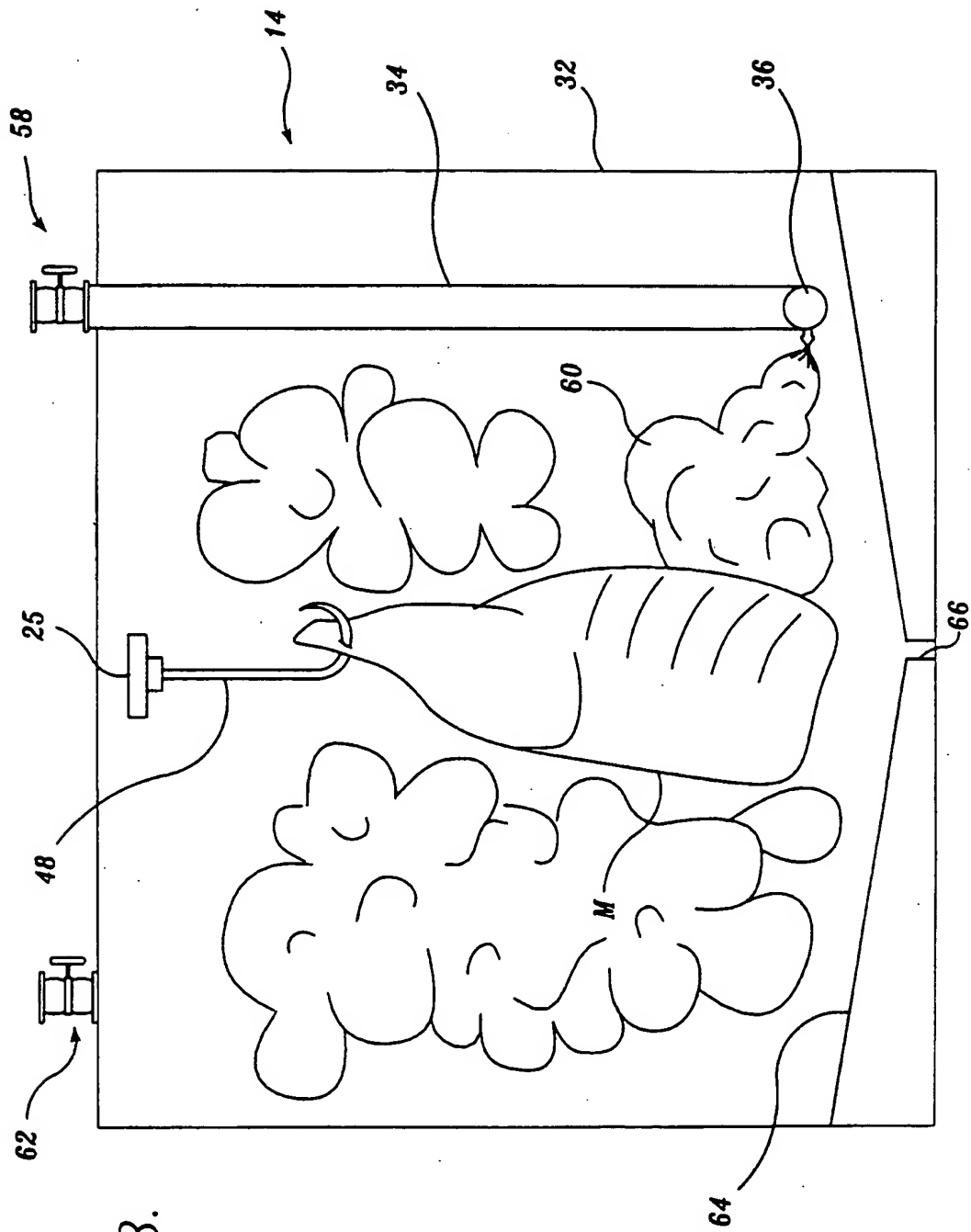


Fig. 3.

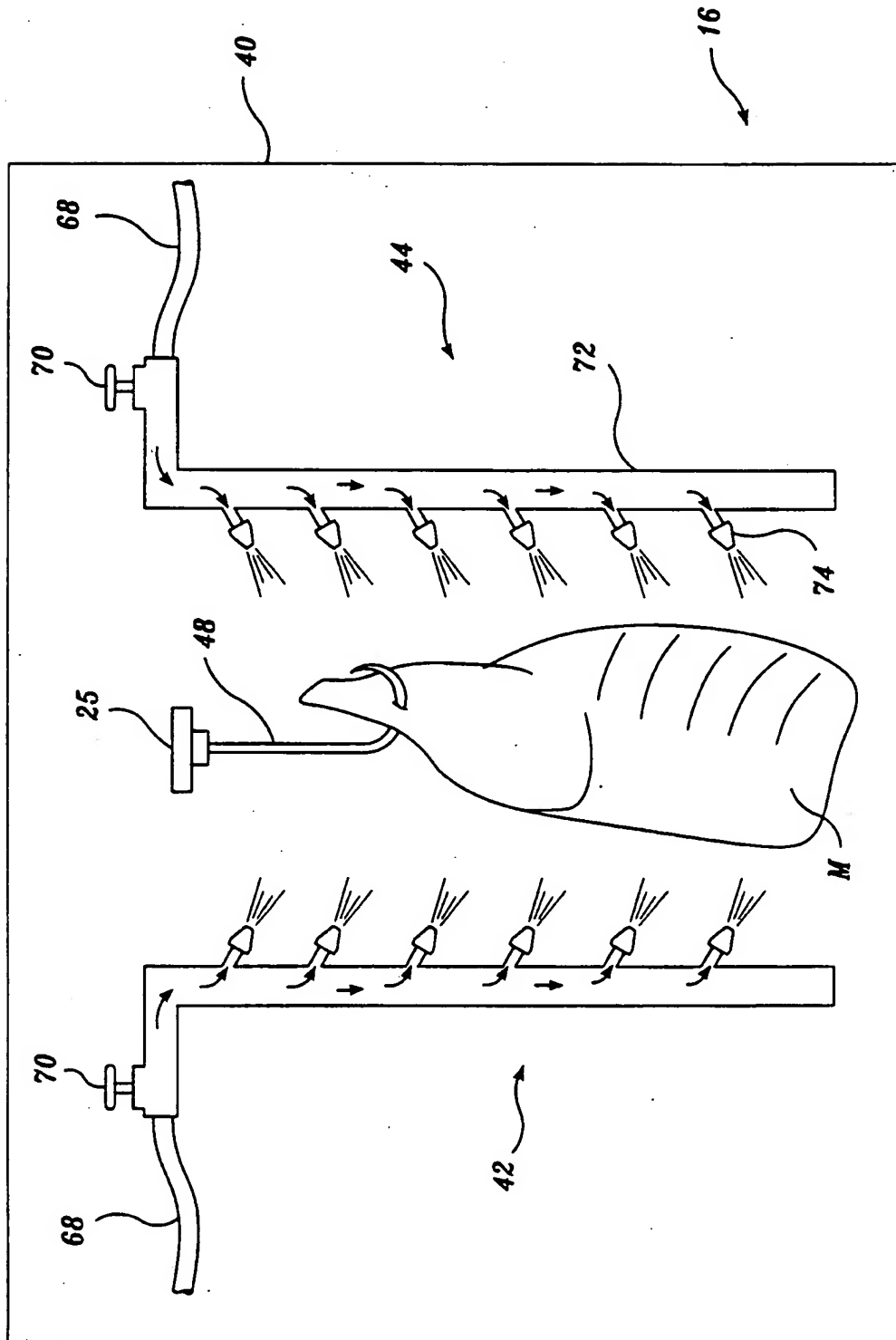


Fig. 4.

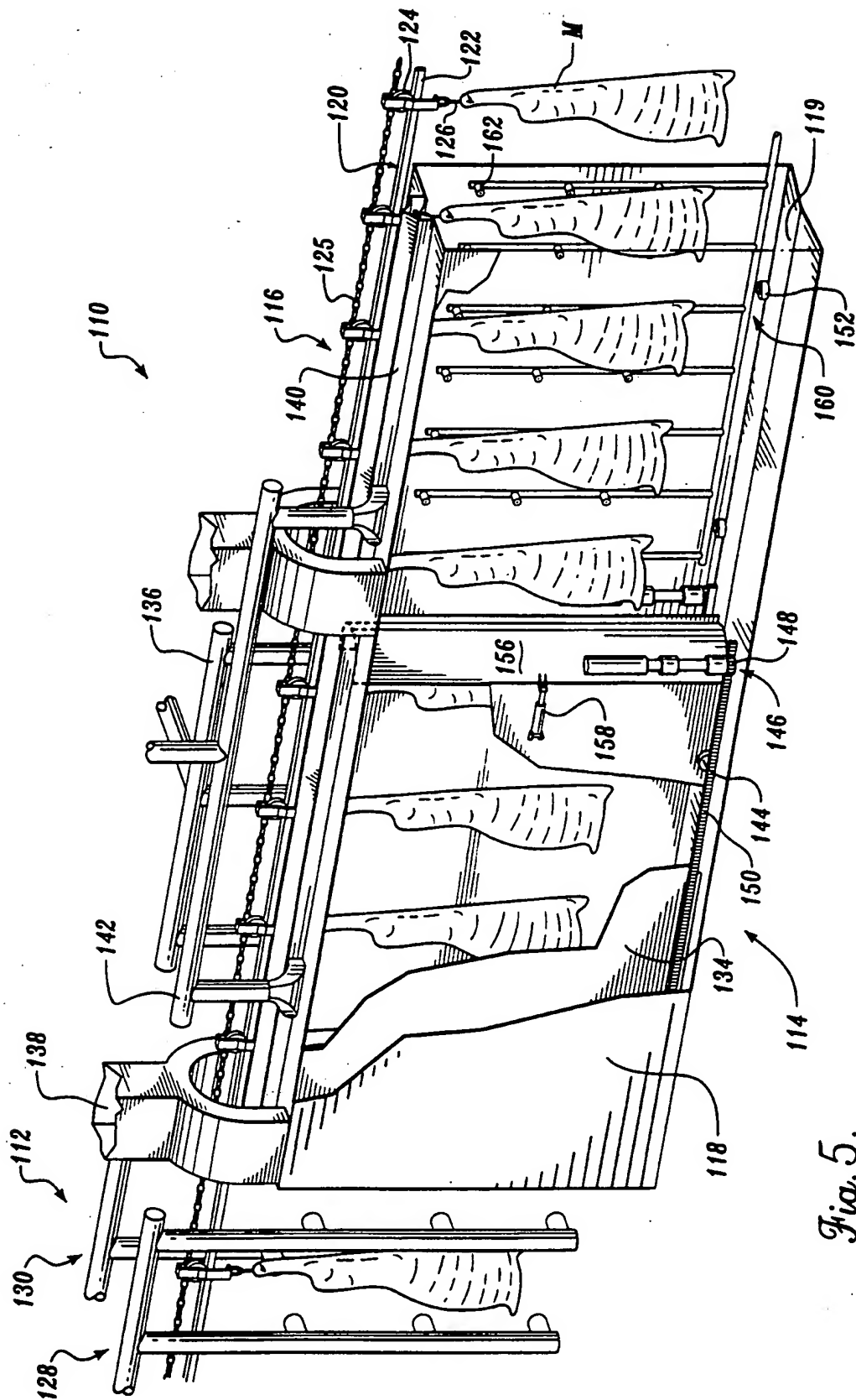


Fig. 5.

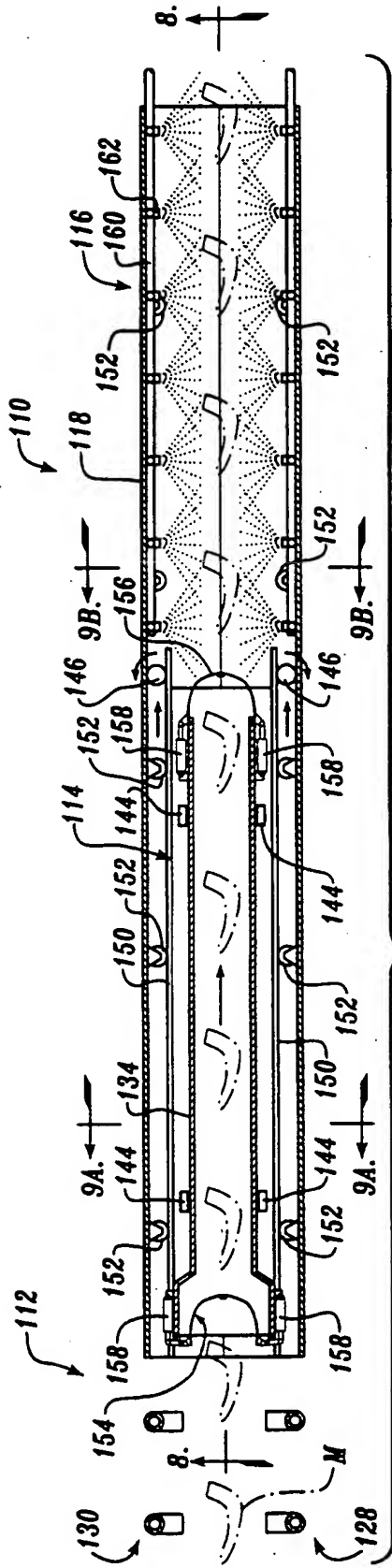


Fig. 6.

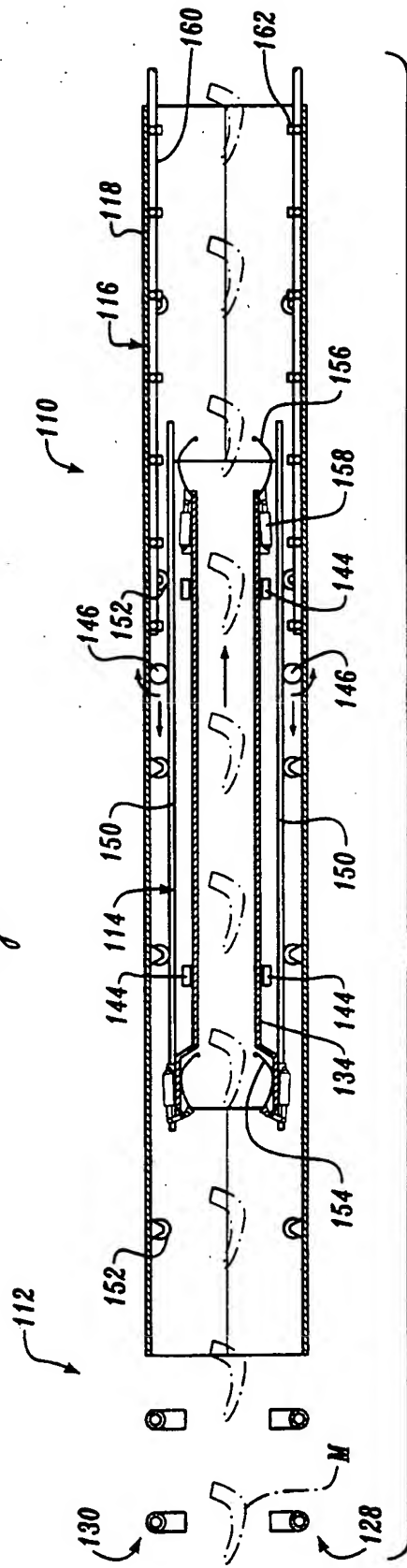


Fig. 7.



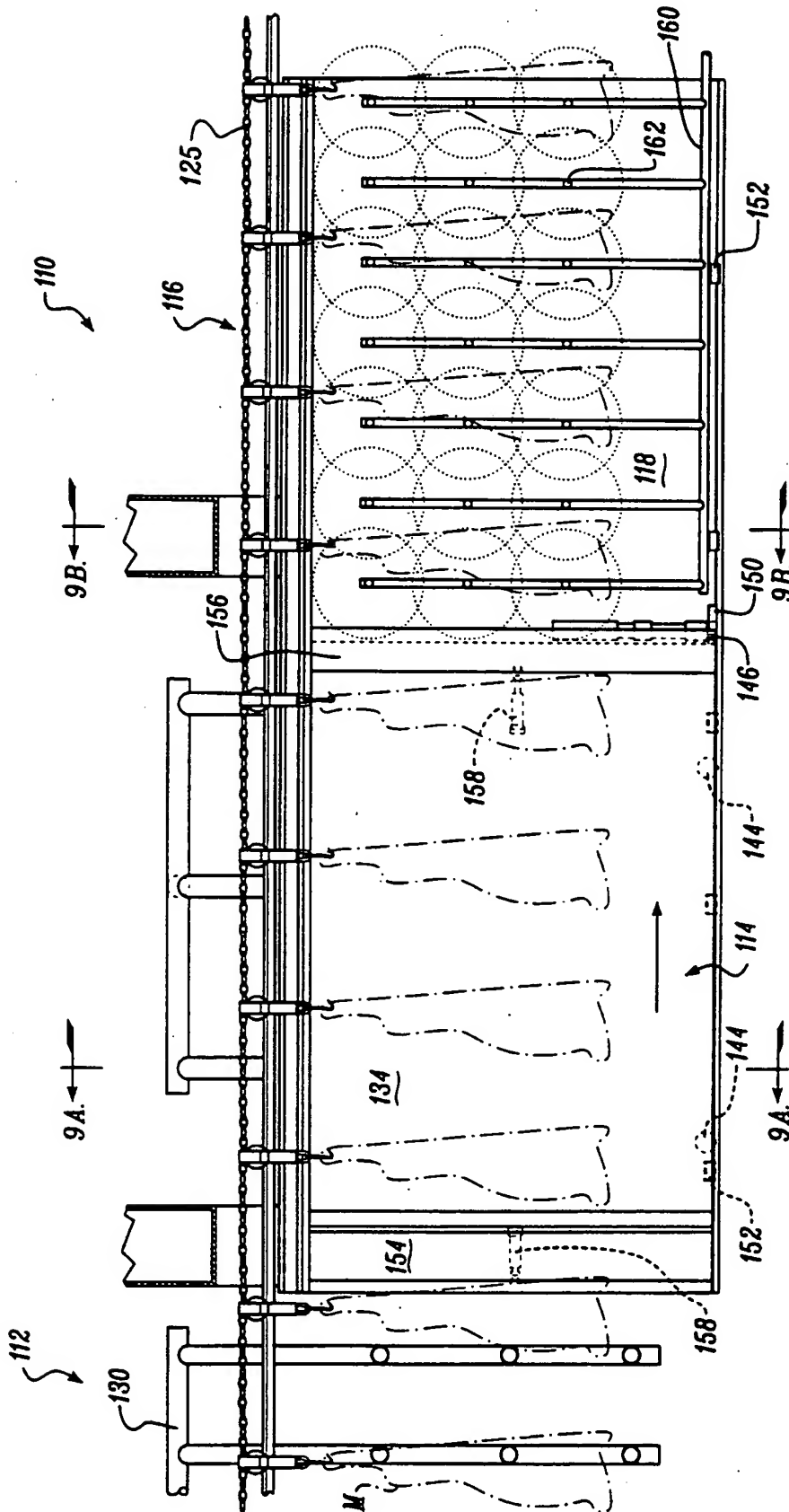


Fig. 8.

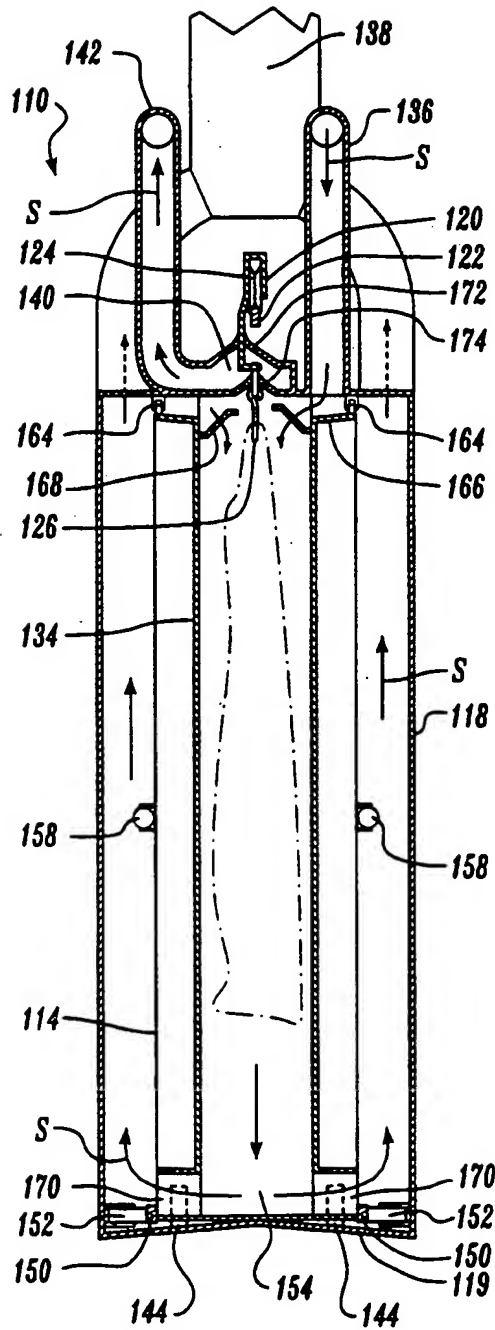


Fig. 9A.

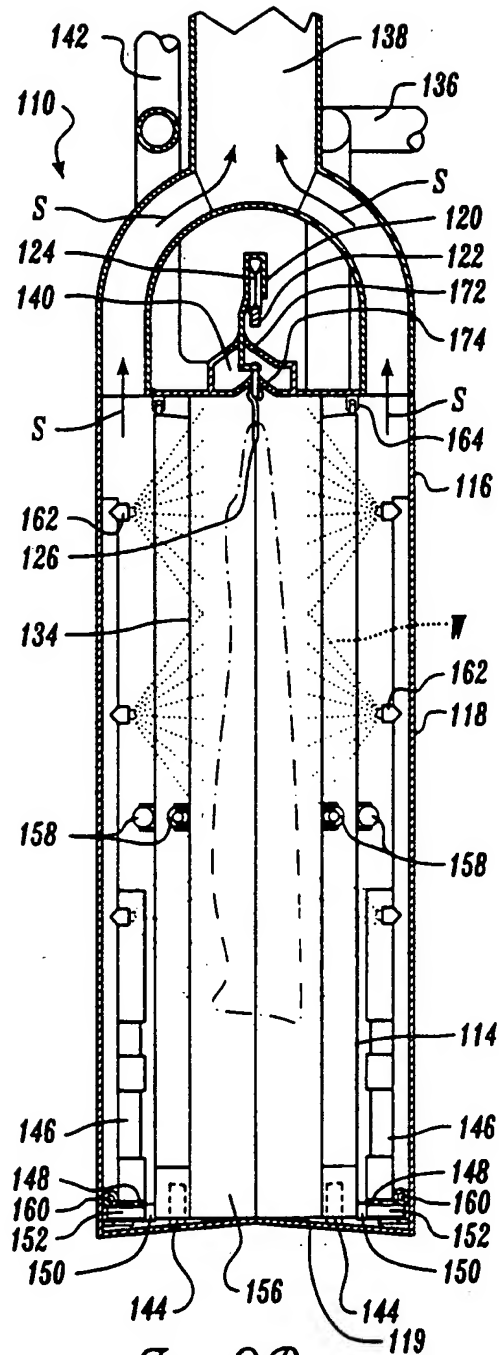


Fig. 9B.

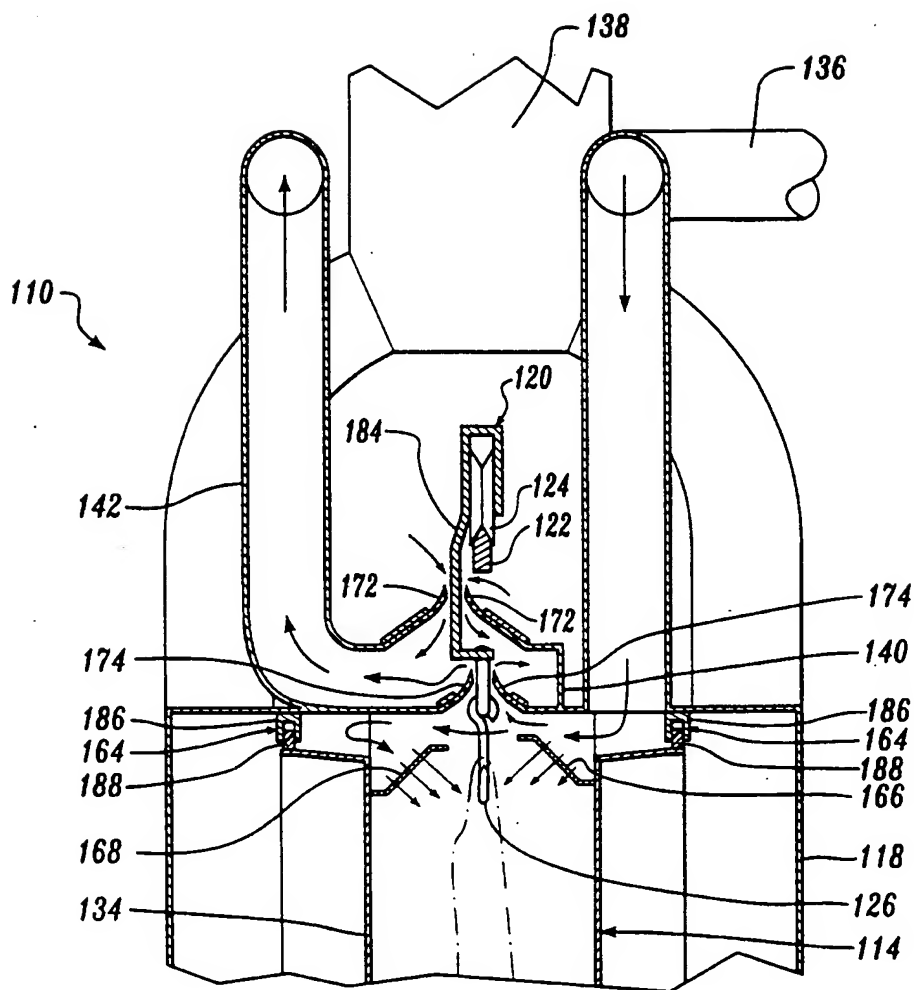


Fig. 10.

Fig. 11A.

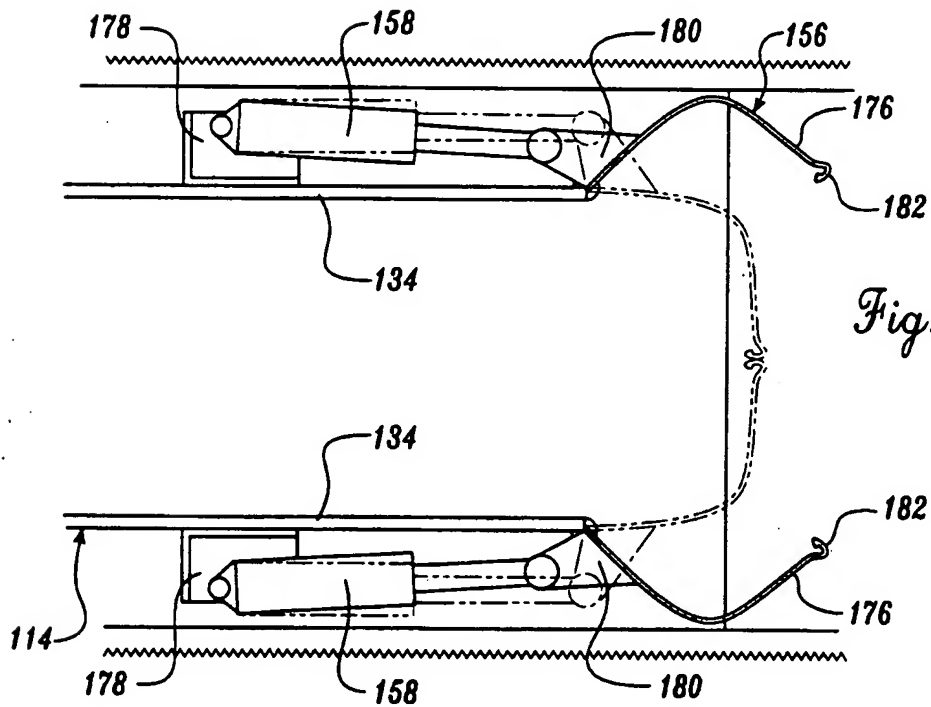
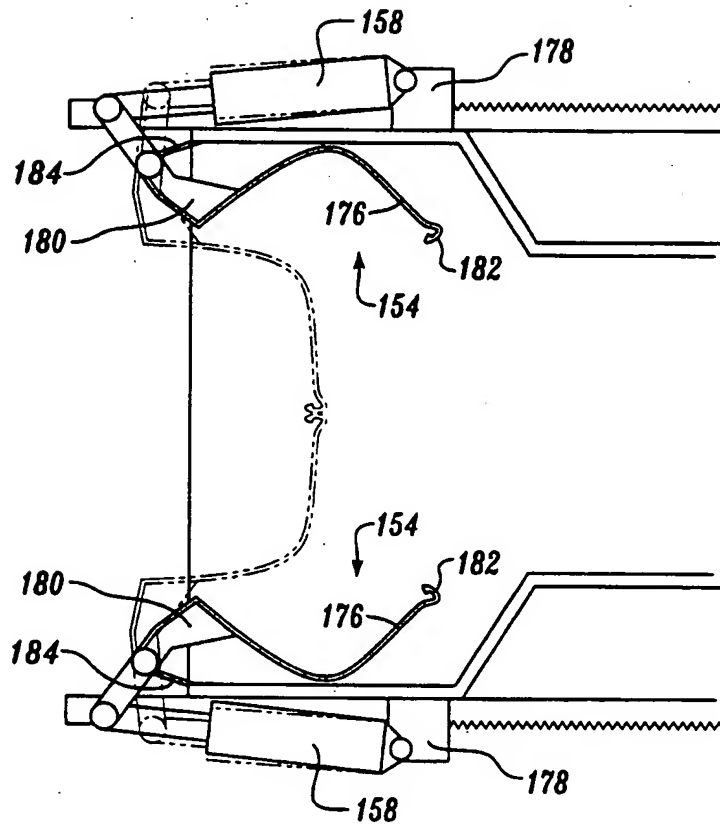


Fig. 11B.

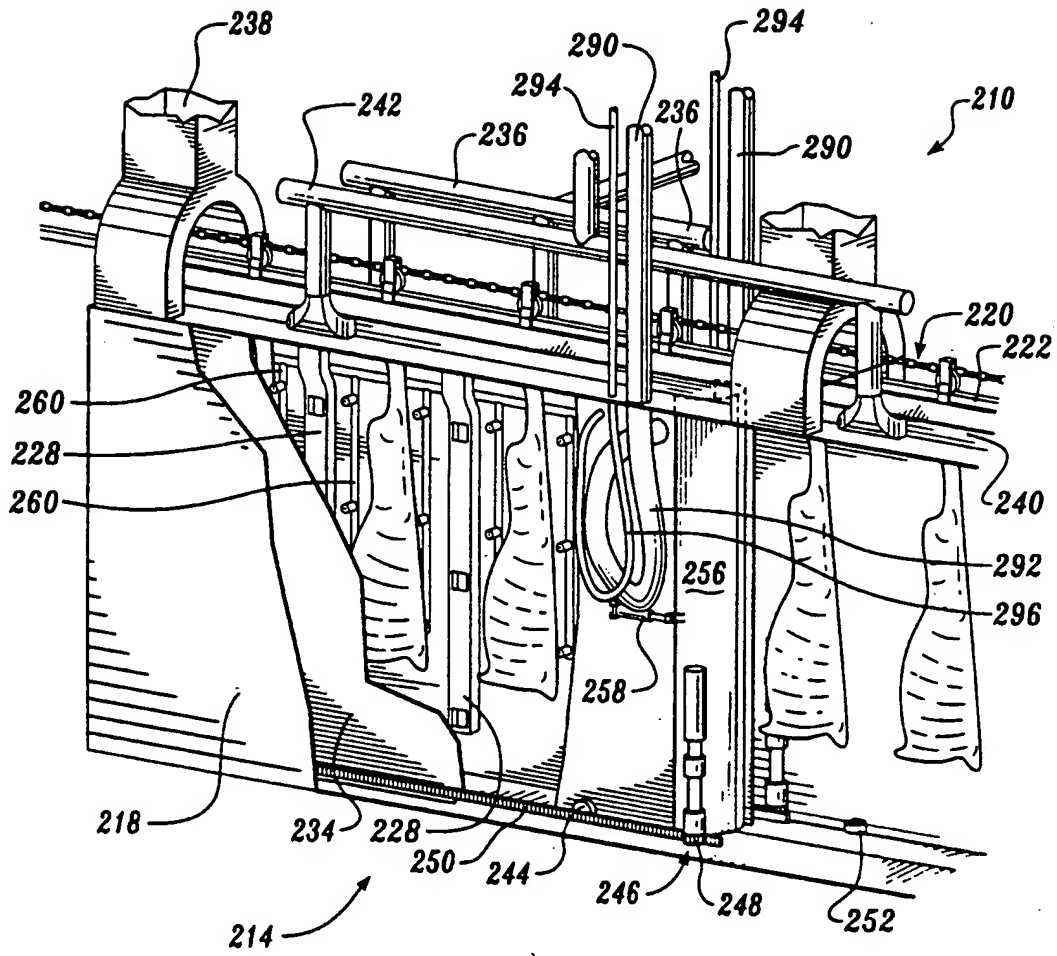


Fig. 12.

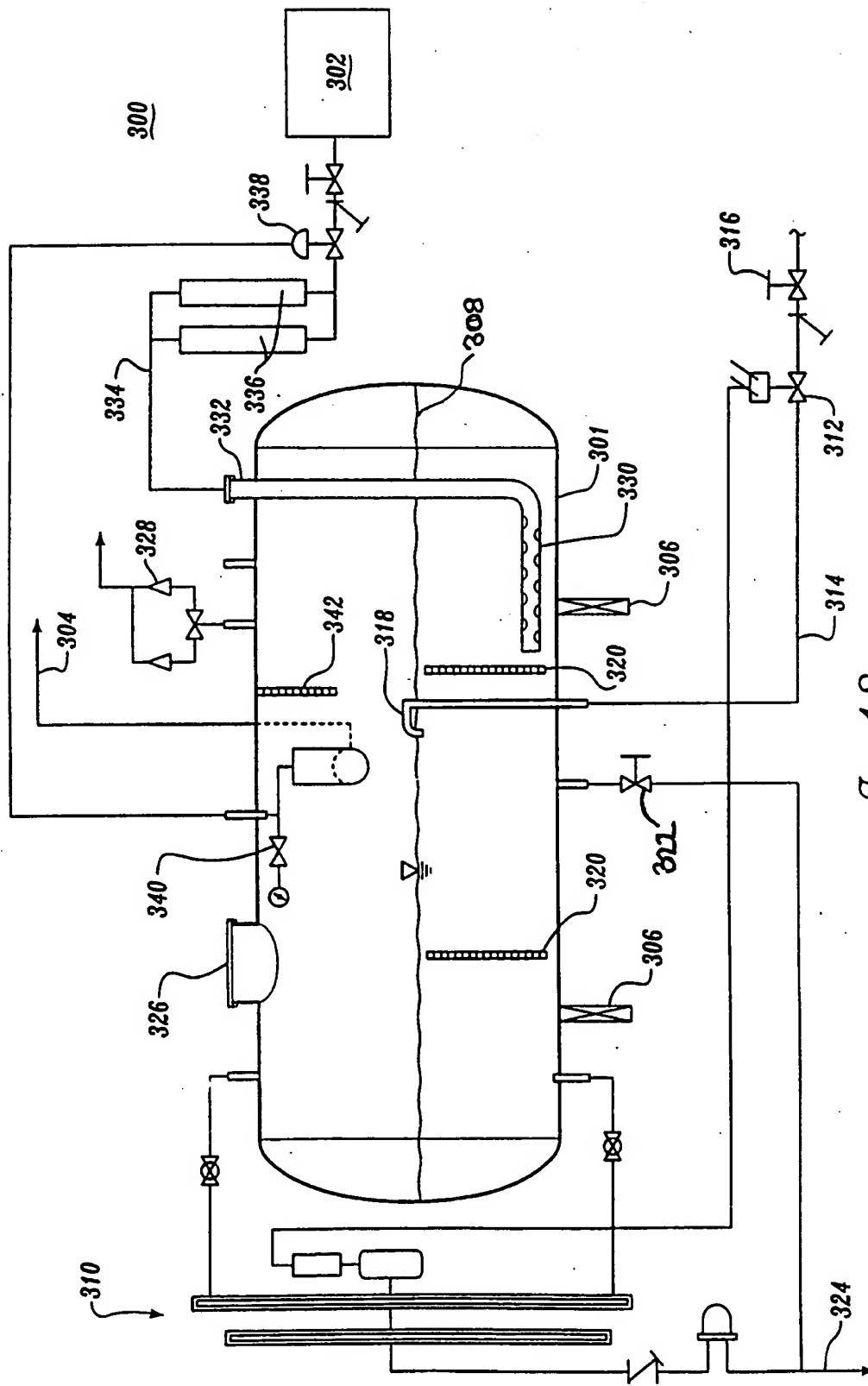


Fig. 13.

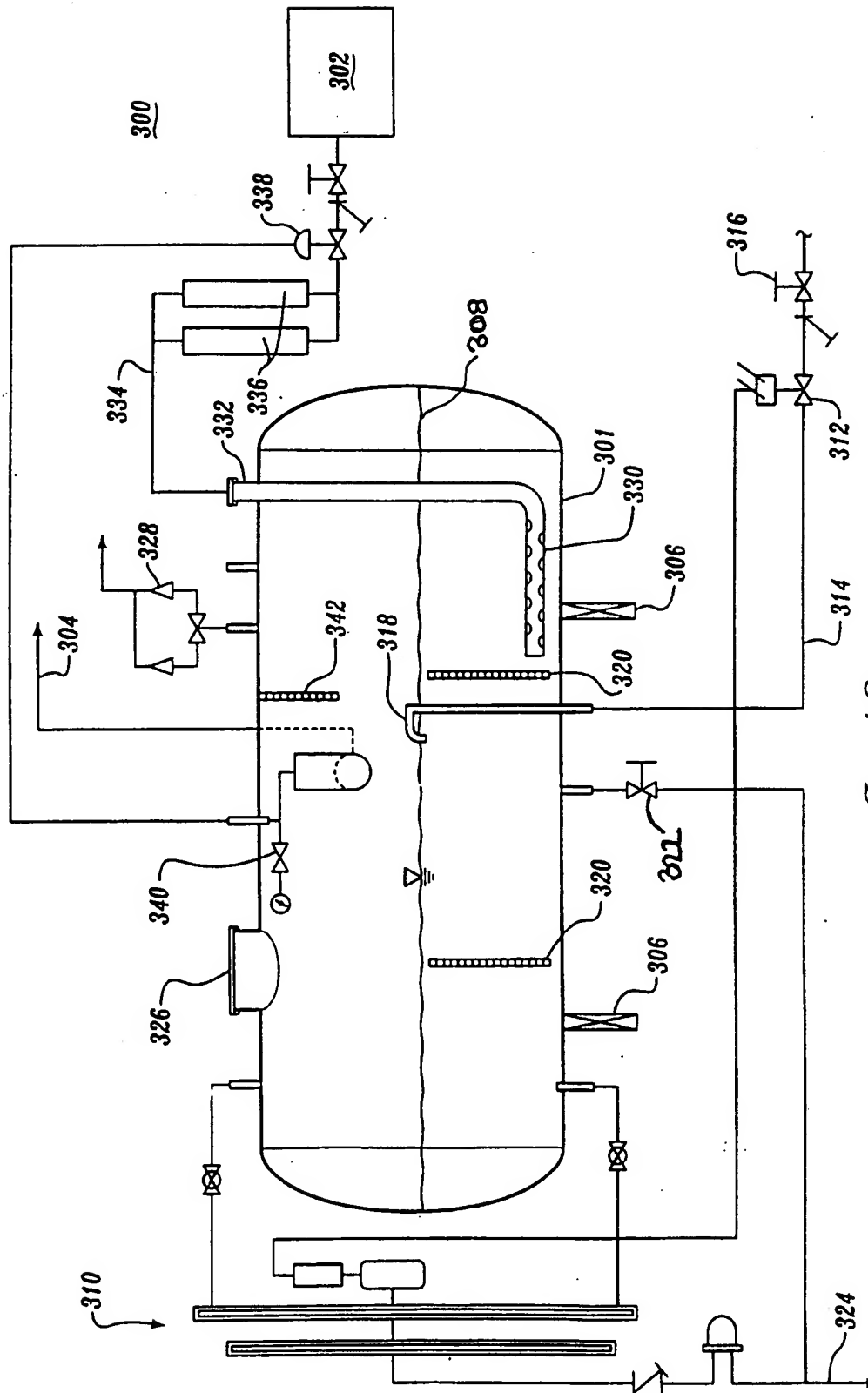


Fig. 13.